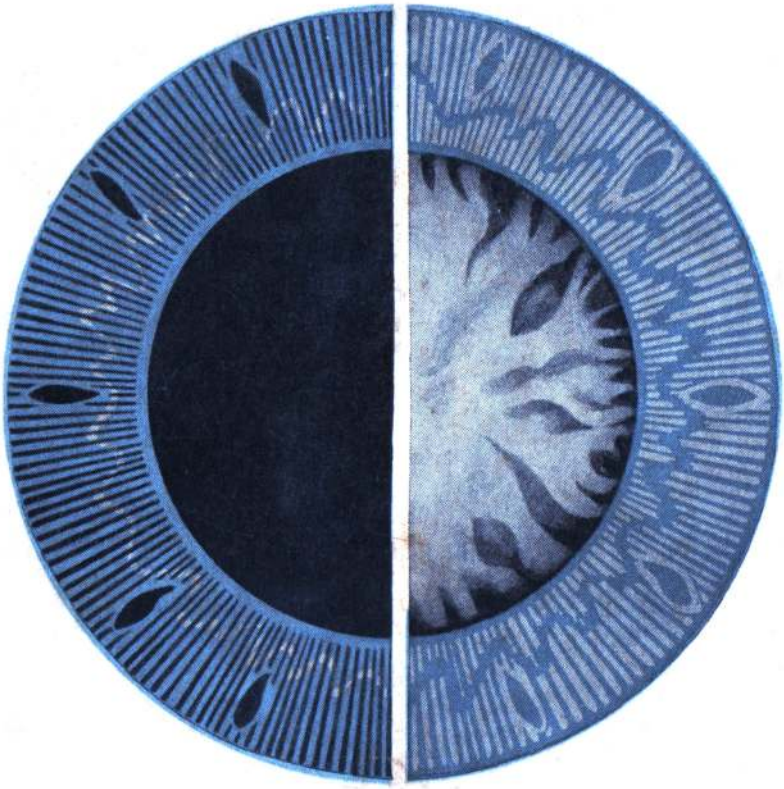


CATARACT

M. RABINOVICH

MIR PUBLISHERS • MOSCOW

The author of this monograph, Mikhail Rabinovich, Doctor of Medical Sciences, is an experienced ophthalmic surgeon. In this work he presents the results of his studies of the problem of the cataract, to which he devoted fifty years of his life.

The monograph begins with a detailed description of a healthy crystalline lens and proceeds to a discussion on the morphology, genesis, and aetiology of the different types of cataract, drawing attention to those most frequently encountered. Methods of cataract diagnosis and the indications and contraindications for the various methods of treatment are also dealt with.

(Continued on the back flap)

Much attention is given to the prevention and to the non-surgical and, in particular, surgical treatment of cataracts. Preoperative and postoperative management is discussed in detail. The concluding chapter dwells on the operative results, methods for the correction of postoperative aphakia, and on the dynamics of the improvement of visual acuity occurring with time.

The book is intended for ophthalmologists, medical students, and for all those interested in the problem of the cataract.

ATHEROSCLEROSIS AND THROMBOSIS

MYASNIKOV, A. (Ed.)

This collection is devoted to one of the most urgent problems of cardiology—atherosclerosis and thrombosis of the cardiovascular system.

The articles are concerned with some new aspects of the pathological anatomy of coronary atherosclerosis, pathophysiologic and physiologic mechanisms of the coronary circulation, the pathophysiologic and biochemical changes responsible for disturbances of blood coágulation in coronary atherosclerosis, and clinical observations on biochemical reactions in coronary insufficiency.

Much space is also given to new methods of treatment of coronary atherosclerosis and thrombosis.

It was edited by the late Prof. A. Myasnikov, Fellow of the USSR Academy of Medical Sciences, former Director of the Institute of Therapy, winner of the "Golden Stethoscope" international prize.

The book is intended for therapeutists, pathophysiologists and biochemists.

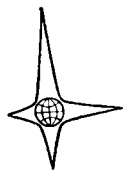
RICKETS

SVYATKINA, K., KHVUL, A., RASSOLOVA, M.

This monograph is written by a group of eminent specialists in paediatrics.

Their work is based on the latest developments in the study of the aetiology and pathogenesis of rickets. The classification and clinical aspects of rickets are described, much attention is given to the important practical problems of diagnosis and differential diagnosis, prevention, and treatment. Chapters are devoted to hypervitaminosis D, ricketslike osteopathy, and to spasmophilia. Appendices contain a set of physical exercises and massage recommended for infants between six weeks and twelve months old.

The monograph is intended for paediatricians and medical students.



MIR PUBLISHERS

М. РАБИНОВИЧ

КАТАРАКТА

ИЗДАТЕЛЬСТВО "МЕДИЦИНА"
МОСКВА

M. RABINOVICH

CATARACT

Translated from the Russian
by
Ludmila AKSENOVA, M.D.

MIR PUBLISHERS • MOSCOW
1968

UDC 017.741-004.1=20

REVISED FROM THE 1965 RUSSIAN EDITION

На английском языке

CONTENTS

Preface 7

CHAPTER 1. *Clinical Anatomy and Physiology of the Crystalline Lens* 9

2. *Cataract-Pathological Condition of the Lens* 14

3. *Diagnosis* 35

4. *Indications and Contraindications for Treatment* 41

5. *Prevention and Non-surgical Treatment* 53

6. *Surgical Treatment* 63

Preoperative Management . . 65

Operation 74

Postoperative Period 124

7. *Complications* 127

8. *Postoperative Results. Aphakia* . . 153

Bibliography 162

Index of Names 171

Subject Index 173

PREFACE

In this work we present the results of our fifty-year's experience in ophthalmology devoted to that vitally important problem in this branch of medicine, cataract.

The subject of cataract which embraces studies dealing with its pathogenesis, prophylaxis, and treatment is still a most urgent and vitally important problem of ophthalmology.

The practicing ophthalmologist is mainly interested in the methods of prevention and treatment, and for that reason the greater part of this work is concerned with that aspect of the problem. Prevention is a science which is only just beginning or may, perhaps, be said to have just begun at any rate, even though in its infancy it has a promising future. As to the treatment (to be more precise, treatment of the patient suffering from cataract) it may be divided into non-surgical and surgical. We use the term "non-surgical" to designate all types of active and advanced therapy, with the exception of the surgery, instead of the rather archaic term "conservative treatment".

M. Rabinovich, D.Sc. (Med.)

CHAPTER 1

CLINICAL ANATOMY AND PHYSIOLOGY OF THE CRYSTALLINE LENS

The *crystalline lens* (lens crystallina), an important constituent of the optical system of the eyeball, is a transparent, semi-solid, biconvex body. It has anterior and posterior surfaces with centres known as poles; the wavy line dividing these surfaces from one another is called the equator and lies a little behind of the ciliary processes. The equatorial diameter of the lens is nine to ten millimetres, its antero-posterior axis connecting the anterior and posterior poles is about 3.6 millimetres. The crystalline lens lies between the iris and the vitreous body, lodged in a saucer-like depression on the anterior surface of the latter (fossa patellaris). The lens and the vitreous body, however, are not in direct contact, being divided by a retrolental capillary space (spatium retrolentale). The periphery of the iris is separated from the anterior surface of the lens by the aqueous humour of the posterior chamber, while its pupillary zone corresponds to the central part of this surface. During dilatation or contraction of the pupil the iris slides over the anterior surface of the lens. This surface is less convex than the posterior: its radius of curvature is ten millimetres, while that of the posterior is six millimetres (Fig. 1).

The accommodative function of the lens effected by its alternating thickening and flattening would not be possible, were it closely joined to the surrounding internal structures of the eyeball.

The crystalline lens consists of two main structures: a non-cellular hyaline *capsule*, and the lens proper formed of *epithelium* and *fibres*. Anterior and posterior parts are distinguished in the capsule. The anterior capsule (between 0.008 and 0.02 millimetres thick) thickens with age. Its

external layers facing the iris at the equator constitute the zonular lamella, formed of fibres of the ciliary zonule (zonule of Zinn) interwoven with the capsule, and are readily separated from the capsule itself. The posterior capsule is much thinner, its thickness at the posterior pole being between 0.002 and 0.004 millimetres.

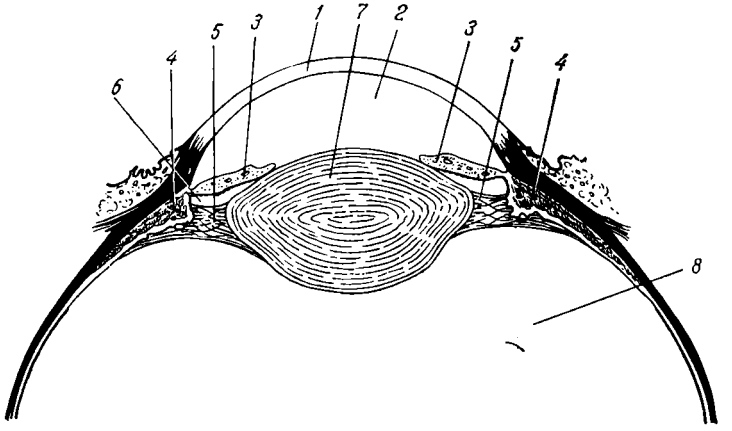


Fig. 1 Anterior segment of the eyeball
1 — cornea; *2* — anterior chamber; *3* — iris; *4* — ciliary body; 5 — fibres of the ciliary zonule; *6* — posterior chamber; *7* — crystalline lens; *8* — vitreous body

The internal layer of the anterior capsule is a product of the epithelial cells which line the back of this capsule (the posterior capsule has no epithelium). Nearer to the equator the epithelial cells are arranged in regular meridional rows, which, gradually becoming longer, are transformed into the lens fibres. Electron microscopy (Cohen, 1965) has shown that the latter are furnished with dents by which they become firmly joined during accommodation. The fibres are shaped like hexagonal prisms. The growing fibre-cells in each meridionally arranged row push the older fibres to the centre of the lens, causing them to be superimposed on one another like the segments of an orange and thus forming radial lamellae. Adjoining lamellae form layers. The fibres grow toward the poles, but never reach them extending only to the so-called lens

star. The rays of the star (nine or twelve in number) are formed by radial lines, and divide the surface of the lens into sectors. New fibres develop throughout life. It might be expected that the lens, enclosed in a dense capsule, would grow continuously in volume, but this does not happen. The lens loses water with age, undergoes sclerosis, and becomes thickened at the centre. This thickening begins as early as 25 or 30 years of age, in an individual over 40 the lens centre becomes a dense nucleus, while its peripheral parts, the cortical layer, remain relatively soft. The transition from soft cortex to dense nucleus occurs gradually. Owing to this process the volume of the lens remains relatively constant at all stages of life.

Lens structure has been studied in detail by means of biomicroscopy. Its substance is not homogeneous in density and because of this, so-called zones of discontinuity are seen in it on examination by slit lamp. The lens centre is poorly illuminated; it is bounded by two bright zones which together have the shape of a bean and are known as the central bands of the foetal nucleus. The peripheral bands of the nucleus circumscribe the central ones and are not as bright. They appear by the time of birth. More peripherally are two bright bands, of the central nucleus; like the lens star, they appear about the age of ten and become more pronounced with years. Zones of discontinuity are seen nearer to the periphery, they become dim with age and serve as orienting points for locating the site of opacity.

The lens is held in place by thin threads of the *ciliary zonule* (see Fig. 1) which consists of many smooth, elastic, structureless fibres originating in the epithelium of the basal lamina of the ciliary body and in the depression between the ciliary processes. The ciliary zonule has a peculiar structure, the fibres originating on its front surface being interwoven into the region of the equator and the posterior capsule of the lens, and those originating on its back surface, into the anterior capsule. By this structure a space is formed between the intertwining fibres, known as Petit's canal, the zonular space, or the spatia zonularia. The ciliary zonule is quite strong in young individuals; with advanced age, particularly in old people,

it becomes fragile and tears easily. This fact is of essential importance in surgical removal of a cataract.

Chemical composition of the lens. About 65 per cent of the total weight of the lens is water. During growth this amount increases to 75 per cent but then decreases greatly with age, the lens undergoing dehydration. About 65 or 75 per cent of the total water content is confined to the elements of the cortical layer, since it is formed from the youngest fibres. The greater part of the water occurs in a free state; a small part is bound.

Proteins make up about 35 per cent of the mass of the lens. It may be noted here that the lens, particularly its nucleus, contains more protein than any other human tissue. Both soluble and insoluble proteins are present. In young individuals the proteins are almost all soluble; they decrease, however, with age, while the amount of insoluble proteins (albuminoids) increases.

The amount of cysteine (an organic compound belonging to the group of amino acids) in the insoluble proteins is negligible, but is quite large in the soluble ones. Cysteine plays a very important role in the vital activity of the lens, taking part in the oxidation processes occurring within it (internal respiration). Its content also decreases in advanced age and tissue respiration in the lens consequently diminishes.

In addition to these constituents, the crystalline lens contains a small amount of lipoids, cholesterol among them, about 2 per cent of inorganic compounds (calcium, phosphorus, etc.), and some ascorbic acid, its amount decreasing with age.

Finally, mention must be made of one further component of the lens tissue, glutathione, which also plays an important role in tissue respiration.

The functions performed by the lens do not require high metabolic activity. Energy is needed only to maintain transparency and to provide the nourishment necessary for the formation and growth of new fibres, and to preserve the elasticity of the capsule. The lens has no system of blood vessels and is supplied with nutrients by mutually supported metabolic processes occurring within it and the aqueous humour. Because of this, qualitative and quanti-

tative changes taking place in the aqueous humour may affect the condition of the lens in one way or another.

From the point of view of colloidal chemistry, the lens is a complex system which maintains its transparency only under certain conditions: it becomes opaque both with the loss of water, and with an increase in its content, with an increase in the concentration of various substances in the anterior chamber, etc. Its optical properties also depend on the permeability of the anterior and posterior capsules.

The lens is a system in a state of an unstable equilibrium that can only be maintained by a continuous supply of energy. In Fradkin's apt expression (1947), we would do better to think about the factors facilitating maintenance of transparency rather than about the causes of opacification. From this point of view, the fact that the loss of transparency and opacity of the lens are a relatively frequent occurrence should cause no surprise.

CHAPTER 2

CATARACT—PATHOLOGICAL CONDITION OF THE LENS

Cataract is a pathological condition of the crystalline lens characterized by its opacity. Strictly speaking, there is no comprehensive, single, and satisfactory classification of cataracts. For practical purposes, however, the classification given below can be used since it embraces as far as possible all the properties of the cataract of interest to us. It has been compiled with due regard for the localization of opacity, its consistency, the time of its appearance, its course, and its aetiology.

According to localization, and partly by shape, the following types of cataract are distinguished: capsular, anterior and posterior polar, lamellar (zonular), nuclear, central, cortical, spindle, and complete cataract. By consistency cataracts may be soft, devoid of a nucleus and hard. According to the time of their appearance, cataracts are known as congenital or acquired, and depending on their course, as non-progressive (stationary) and progressive (Fig.2).

It is very difficult to classify cataracts according to their aetiology, because this remains a moot problem; no classification based on aetiological factors can be considered comprehensive. Nevertheless, we may point to some aetiological features without claiming to have given a complete picture. These include congenital developmental anomalies and defects of the body as a whole and of its separate organs and tissues, diseases of the central nervous and the endocrine systems, systemic and local injuries (mechanical, chemical, thermal, radiation, etc.), age changes, intoxication, and poisoning.

We shall deal only with those types of cataract that, being of greatest importance clinically, are of real interest to the practicing ophthalmologist.

The aetiological factor that can be taken as the basis for classification is closely associated with the concept of simple and complicated cataracts. "Simple cataract" requires no particular explanation; but this is not so with regard to "complicated cataract". How should one understand this term? What types should be included in the group of complicated cataracts? There is no unanimity of opinion on this point. Some ophthalmologists include in this group those types of cataract that occur from causes of a general character, such as diabetes, tetany, electric current, and X-rays.

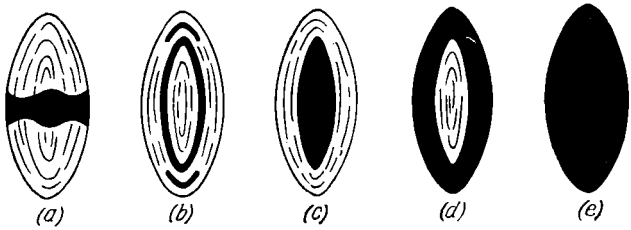


Fig. 2 Schematic representation of the clinical types of cataract
a — spindle; *b* — lamellar; *c* — nuclear; *d* — cortical; *e* — complete

If, however, we accept this opinion, we must rule out the group of simple cataracts. Since a cataract that occurs in diabetes or tetany is regarded as complicated, why should a senile cataract not also be considered complicated? It is encountered, after all, during the senile involution of the body and is either a result or a concomitant condition of that involution and is not a complication of the principal disease, but one of its manifestations.

Another, much larger, group of authors considers that only those cataracts due to diseases of the eye itself are complicated.

The term 'cataracta complicata' was introduced by Becker (1876) who defined this type of cataract as a condition subsequent to a disease of the eye structures (retinal detachment, cyclitis, glaucoma, etc.).

Complicated cataracts may be divided roughly into two groups: those that occur in the posterior parts of the lens

in diseases of the back segments of the eyeball and which display characteristic morphological features (the first group); and those encountered in pathological conditions of the front segments of the eyeball, which start in the anterior layers of the cortex and possess no such characteristic features (the second group). Whatever the aetiology of the cataract, the treatment should be complex, and should involve both measures that produce a general effect on its cause (senility, diabetes, etc.), or its after-effects where the cause is a single event to which the body has been exposed (any kind of injury, etc.), and the use of therapeutic agents that produce a local effect (medicinal treatment). If we are considering surgical treatment, a distribution into simple and complicated cataracts as follows will prove most feasible: a complicated cataract is one that is a complication of any disease of the eyeball itself; all other cataracts are simple. This distribution is the more justified since a complicated cataract as such has its own particular features which will be described further. From the purely practical point of view, all types and forms of the cataract can be taken as simple or complicated according to these properties.

SIMPLE CATARACT

CONGENITAL CATARACT

The incidence of congenital cataract is very low. This is indisputable and may be considered a proven fact.

From data on 3,000 patients treated for cataract, the congenital type averaged 5 per cent of the total number of cataracts treated at the clinics concerned. The remaining 95 per cent were acquired cataracts, and 95 per cent of them senile. The high percentage of senile cataracts calling for surgical treatment (the figures mentioned refer only to such cases) should cause no surprise. As may be seen from Fig. 3, this type is a very frequent among elderly, aged, and very old people.

Lamellar cataract is the type of congenital cataract most frequently encountered and is normally bilateral. Fig. 4 illustrates the condition, which is marked by the

presence of several opaque layers in the central part of the lens between its transparent peripheral (i.e. anterior and posterior) layers. Dented processes, the so-called riders, saddle the opacities.

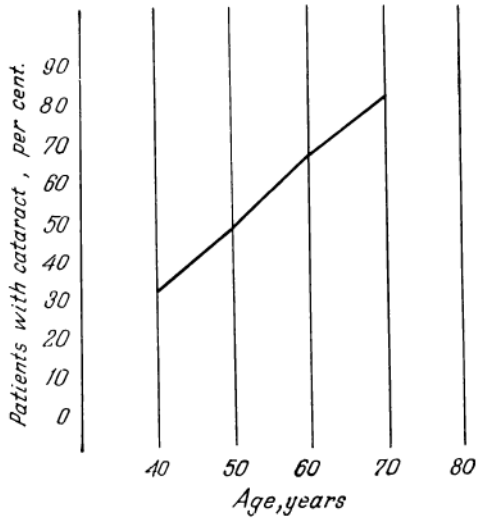


Fig. 3 Distribution of the incidence of senile cataract by age groups

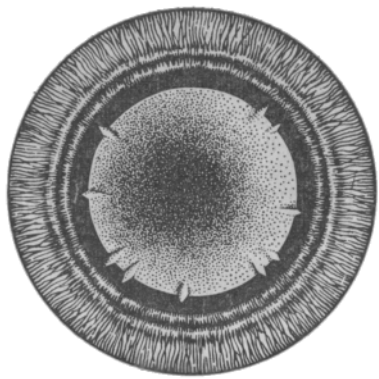


Fig. 4 Lamellar cataract

It is thought that the occurrence of a lamellar cataract is due to hypofunction of the thyroids causing calcium deficiency in the body. Lamellar cataract is frequently encountered as a concomitant condition in rickets and spasmophilia.

Visual acuity is usually reduced. The degree of impairment, which depends more upon the density of the opacity than upon its size, predetermines the indications for treatment (which may only be surgical), and for choice of operative technique.

Complete soft cataract (Fig. 5). As indicated by its name, the condition is characterized by complete grey opacity of the lens. Most frequently, this grey mass undergoes

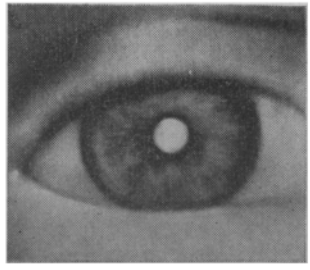


Fig. 5 Complete soft cataract

resorption in time as the child grows. The lens is replaced by a dense capsule (membranous cataract or cataracta membranacea) which is sometimes covered with deposits of white lime salts or yellow cholesterol crystals. Membranous cataract is often encountered in association with other anomalies, such as microphthalmus, nystagmus, and strabismus. The disease is only treatable by surgery, but it must be said that visual prognosis is not very promising because of the anomalies mentioned.

ACQUIRED CATARACT

We shall describe the senile and endocrine cataracts here because they are those most frequently encountered in practice, this being particularly so of senile cataracts.

Senile Cataract

The opacities occur as a rule in the cortical layers of the lens and at its equator. They are seen as strips or narrow sectors with their base toward the equator. In exceptional cases the cataract may also be encountered in the cortical layers either surrounding the nucleus (supranuclear cataract or cataracta supranuclearis), or, less frequently, within the nucleus itself (nuclear cataract or c. nuclearis). At this developmental stage the cataract is known as incipient (c. incipiens; Fig. 6*a*).

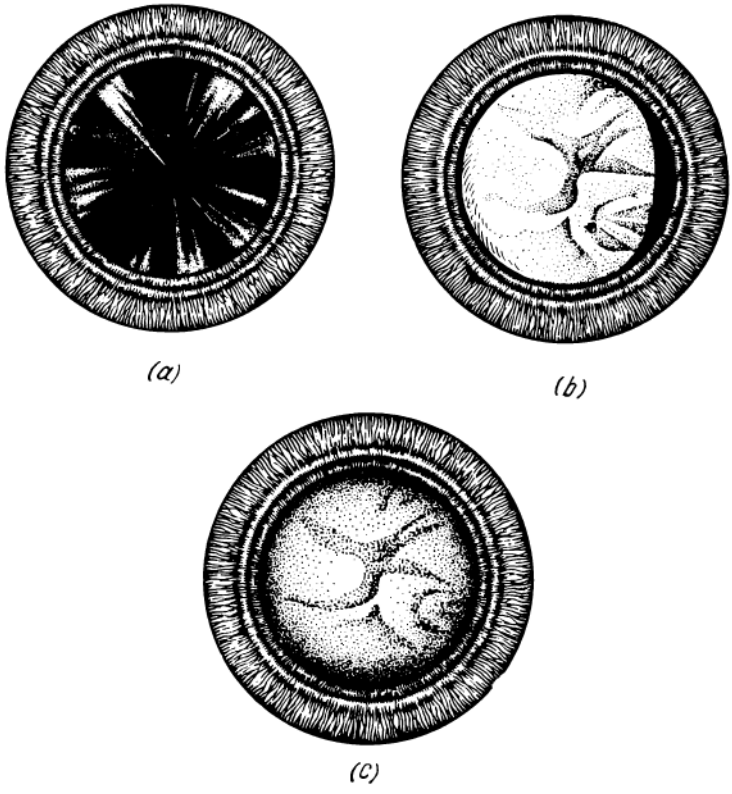


Fig. 6 Senile cataract
a — incipient; *b* — immature; *c* — mature

As an untreated cataract develops further, the opacities grow in size, coalesce, and involve ever larger areas of the lens, and it reaches the second developmental stage, immature cataract (c. nondum matura; Fig. 6*b*).

Later the cataract develops into an almost mature type (c. fere matura), the third stage; finally, all the matter of the lens becomes opaque and the cataract matures to the fourth stage, mature cataract (c. matura; Fig. 6*c*).

There is finally one further stage; during it, unlike stages already described, the cataract does not progress but regresses. This is the fifth stage, the hypermature cataract (c. hypermatura). The process of regression takes one of two diametrically opposite forms. With the one most frequently encountered, the lens loses much water, shrinks and becomes hard, and cholesterol and lime crystals are deposited on the degenerated capsule. With the other, rarer, form, the cortical substance liquefies and is converted into a milky-white fluid, while the nucleus moves down (Morgagnian cataract, c. Morgagniana).

We have described the stages of development of cataract because correct knowledge of the condition of the lens is essential in practice. With an incipient cataract, for example, lens condition is most favourable and the results of non-surgical treatment are hopeful. The second stage, during which the lens becomes swollen (for this reason it is also known as intumescent cataract or c. intumescens), requires close attention because it is often complicated by an increase in intraocular pressure, with all its attendant consequences.

Attention must on no account be relaxed after a cataract has matured. This is the period most favourable for operation because the extraction of a hypermatured cataract cannot only present many difficulties, but may also give rise to extremely serious after-effects.

Sooner or later, as a rule, a senile cataract affects both eyes. This is quite understandable, since the "operating mechanisms" responsible for its occurrence are located somewhere extraocular and affect both eyes. Owing to the presence of specific conditions, however, cataract does not develop simultaneously on both eyes, and maturation also occurs in a different manner. For example, it may have reached

a state of relative maturity, calling for surgical treatment, in one eye, while the other retains relatively fair vision. This circumstance is very significant because the state of the less affected eye is a factor in deciding the time for operation on the worse one.

For purely practical reasons we consider it necessary to dwell briefly on the pathogenesis of the origin and formation of a senile cataract since modern therapy can rightfully be called pathogenetic.

There is no doubt today that certain systemic disorders encountered as the body ages play a role in the origination of senile cataract. By this, however, we do not wish to infer that no role is played by so-called local conditions, in other words, by the state of the eyeball structures, and of the lens itself, in particular. It seems to us, however, that age changes, in combination with local factors, specific to the lens lead to opacification and to the development of a senile cataract.

Efet (1961) established that the total cholesterol content in the nuclear proteins of an opaque lens is 50 per cent greater than in those of a transparent lens, the amount being less in the insoluble proteins and at the same time double in the water-soluble proteins. From these facts he concluded that "lens opacification in senile cataract is associated with disorders of cholesterol metabolism in the lens proteins". Changes in the ratio of lipids within the lens evidently play a certain role in the development of cataract: combined lipids (lipoprotein complex) prevail in a transparent lens, and free lipids in an opaque one.

It must be confessed that the pathogenesis of senile cataract is still obscure. Roughly it may be pictured as follows. The principal role is played by disorders in the metabolic processes and by impairment of tissue respiration which is mainly regulated by the three most important body systems, the central nervous, the endocrine, and the cardiovascular, which undergo certain changes associated with age. Local conditions, like the state of the lens, also play a role in the process of opacification. They point to disorders of lens respiration, indicated by the biochemical shifts discussed in Chapter 1 (decrease in content of cys-

teine, glutathione, ascorbic acid) and by a decrease in the content of riboflavin.

The origin of a senile cataract may thus be explained by disorders of the metabolic processes in the lens without disturbance of the relation between its functions and structure. The changes in the lens occurring with age begin at the equator, where the epithelium also begins to change, its cells growing in size, the nuclei becoming harder, etc. Injury sustained by the epithelium is always attended by opacification of the lens fibres. It will be remembered that the lens has no blood vessels and nerves of its own and only the epithelium of the capsule controls its metabolism. Hence damage to the epithelium leads to metabolic disorders.

Cataract due to Endocrine Dysfunction

So-called *diabetic* cataract (Fig. 7*a*) greatly concerns ophthalmologists. We say "so-called" because some authors deny the existence of diabetic cataract as such. Others, while casting doubt on its existence, point out that diabetes may hasten the origination and rapid maturation of a senile cataract, age being a prerequisite for its appearance.

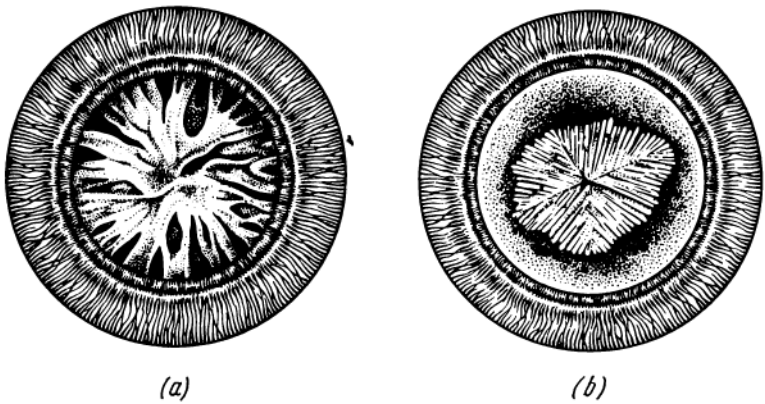


Fig. 7 Cataracts due to endocrine dysfunction
a — diabetic; *b* — cataract in tetany

The majority of authors, to which we also belong, implicitly acknowledge the existence of this type of cataract. The following factors convince us of the correctness of this position: (1) the occurrence of this cataract in young individuals with no other conditions, except diabetes, that might cause its appearance; (2) although there are no absolutely reliable symptoms to distinguish a diabetic cataract from other forms, certain features, nevertheless, may be encountered. One of them is its rapid maturation, occurring sometimes with almost lightning speed. A number of cases have been described of a diabetic cataract developing within several days or even hours.

We observed the following case some years ago.

N. S., a 28-year-old woman, came to the clinic with blindness of the right eye and impairment of visual acuity in the left. She stated that she had been examined four weeks previously, when the visual acuity of both eyes was found to be 1.0 and the lens completely transparent. Examination revealed a complete cataract in the left eye and an incipient one in the right; we witnessed maturation of the latter within only 21 to 25 days.

A diagnosis of diabetic cataract was not difficult in this case for, apart from the fact that the patient had diabetes, it was found that both cataracts had appeared and developed almost simultaneously and that on the left eye had those meagre features considered characteristic, almost pathognomonic, of a diabetic cataract as described in the specialist literature: the cataract appears in the surface layers of the lens under the capsule and is formed of bright coloured vacuoles and of separate opacities with serrated edges, but sometimes net-like.

There is no unanimity on the mechanism of formation of diabetic cataract. Summarizing all opinions, one may state that it appears as a result of the toxic effect of pathological metabolism products at first on the epithelium of the capsule and later on the layers lying directly under it, and as a result of impairment of the mechanisms responsible for sugar assimilation in the body.

The problem of the incidence of diabetic cataract needs to be approached with care, bearing in mind how little uniformity there is on singling it out from other forms of cataract. We found no clear information on this point in

the statistical data available in the literature. Summarized data for a large number of cases studied by five authors indicate that, on average, 15 per cent of diabetic patients suffer from cataract. Our own observations agree closely with this figure. More precisely, we can state that in a group of about 125 diabetic patients examined by us there were not more than ten (8 per cent) unquestionable cases of *diabetic* cataract. Pirie (1965) writes, on the basis of his observations, that diabetic patients are four times more susceptible to cataract than individuals not suffering from this endocrine dysfunction, and explains this by an increased content of sorbitol, glucose, and fructose in the lenses of diabetics.

In the group of cataracts due to endocrine pathology, we may draw attention to yet another type, which is encountered in *tetany* resulting from insufficiency or complete dysfunction of the parathyroids (c. parathyreopriva) (Fig. 7*b*). Hypoparathyroidism is a condition either resulting from injury to the hypothyroids and their complete removal, or being of an idiopathic nature, and is responsible for marked biochemical shifts, deficiency of calcium ions in the blood being the principal one. This deficiency gives rise to a systemic disease, tetany, and to the development of a specific cataract, which has certain features in common with diabetic cataract. One of these is unusually rapid maturation, which may be illustrated by a follow-up of V. A., a 25-year-old female patient whose parathyroids were removed during a total thyroidectomy. The morphological resemblance shows in the presence of dust-like opacities and crystals of various colours in the cortical layers of the lens, directly under the capsule. The cataract which develops in tetany not infrequently involves both eyes at the same time, as with diabetes.

The pathogenesis of the cataract encountered in tetany is still not known. It is probable that a reduced calcium content in the aqueous humour, due to hypocalcaemia, increases the permeability of the capsule and facilitates the penetration of some toxic agent or other into the lens tissue.

COMPLICATED CATARACT

Complicated cataracts may be divided into two groups. In the first are cataracts that arise from pathological processes taking place in the posterior segments of the eyeball (high or severe myopia, pigmental degeneration of the retina, detachment of the retina, etc.). The second group includes cataracts caused by pathological processes occurring in the anterior segments of the eyeball (uveitis, heterochromia of the iris, secondary glaucoma, etc.).

The cataracts mentioned are endogenic, but complicated cataracts may also be exogenic, e.g. those due to trauma and medicaments. Radiation cataract, which is included in the traumatic group, may be called exogenic-endogenic, as will be seen later.

Most endogenic complicated cataracts originate from metabolic disorders arising in the lens when toxins penetrate it from the intraocular fluids. Changes in the lens first appear mainly in the region of the posterior pole since the posterior capsule is more permeable, being thin and possessing no epithelial barrier. The nearness of the posterior layers of the lens to the primary focus, to the retina in cases of detachment, to the vitreous body in myopia, etc., also plays an obvious role.

Vogt (1922) points out that the suture system as a locus minoris resistentiae presents an additional factor determining localization of opacities.

Complicated cataracts of this group have one feature in common, the formation of flaky laminated opacities with a polychromatic lustre (usually red or blue) under the posterior capsule. Developing, these opacities acquire the shape of a rosette with a dark centre and coloured edges.

The opacities spread both to the centre of the lens and to the periphery. Duke-Elder (1945) draws attention to two characteristic signs for distinguishing complicated cataracts from other types: the presence of a coloured lustre, and the absence of clearly defined borders to the opacity which is surrounded by a haze. A thickening of the capsule due to epithelial proliferation (Fig. 8) may also be noted.

THE FIRST GROUP OF COMPLICATED CATARACTS

Cataract associated with myopia is encountered in high progressive myopia and has the features typical of complicated cataract—it appears first in the posterior cortical layers and is usually a bowel-shaped with the concavity facing forward, but sometimes in the form of a black and nuclear cataract. Its main feature is extremely slow maturation with, sometimes, simultaneous involvement of both eyes. Myopic cataract is usually encountered in advanced age; this makes difficult its differentiation from an atypical senile cataract.

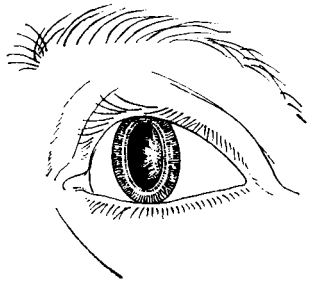


Fig. 8 Complicated cataract

Cataract as a complication of pigmental degeneration of the retina. Posterior polar cataract is typical of this form. It is usually rather late in appearance and progresses slowly, but is responsible for a marked decrease in visual acuity since it is located in the central parts of the lens, just in front of the only segment of the retina which has retained visual functions.

Cataract associated with retinal detachment is characterized by rapid development of a diffuse opacity, followed by lime degeneration and shrinkage of the lens. It usually occurs with old and extensive detachments, and even surgery, the only possible method of treatment, rarely proves effective, although it may sometimes produce results. Surgery is relatively indicated even when there is only an uncertain projection of light on the eye with the detachment, when the other eye is blind. The favourable results obtained

by us after extraction of a secondary cataract membrane in several patients have convinced us that it is possible to improve vision in the presence of a detachment by removing the optical impediment (see Chapter 8).

THE SECOND GROUP OF COMPLICATED CATARACTS

Cataract due to uveitis is usually encountered in subacute inflammatory processes and in sympathetic ophthalmia. It is usually late in appearance and progresses slowly. The condition is preceded by the formation of posterior synechiae and of a plastic exudative membrane that grows over the lens and covers it. With arrest of the inflammatory process, progression of the cataract also ceases, while developing uveitis is attended by growth of lens opacity.

It is to be supposed that the toxins cannot penetrate the hard lens nucleus and because of this the lens retains its transparency for a lengthy period. It may be that these toxins are those that caused the principal disease of the eye, but one cannot dismiss the possibility that they are of secondary origin and are products of the primary degenerative-inflammatory process.

Heterochromic cataract is attended with thin, grey-white, transparent disparate precipitates, discoloration of the iris, and silvery opacities in the vitreous body. These changes are reinforced later by an increase in intraocular pressure. The syndrome was first described by Fuchs. Precipitates may be absent in a variant of this type of heterochromia. Gonioscopy reveals the presence of newly-formed vessels in the angle of the anterior chamber, which pass in a radial direction and form arches. This is a very essential finding and should be borne in mind during extraction of a heterochromic cataract, a procedure almost inevitably accompanied by haemorrhage.

Fuchs' syndrome is attended neither by inflammatory phenomena nor synechiae, but not infrequently, it is encountered in association with Horner's syndrome, ptosis, miosis, and enophthalmos. The process is unilateral, as a rule, and only rarely bilateral. Aetiologically, heterochromic cataract is assumed to be associated with trophic disorders in the vascular tract, connected with pathology of the sympathetic nerve.

Cataract associated with glaucoma. This type of lens pathology may occur in either of two ways: (1) glaucoma develops during pathological processes in the lens in the form of secondary glaucoma; or (2) cataract involves an eye affected by primary glaucoma.

Swelling and hypermaturation of a progressively developing cataract, capsular exfoliation, and dislocation of the lens precondition an increase in intraocular pressure. These changes may give rise to an acute attack of secondary glaucoma calling for urgent measures (which are described in a subsequent section).

Ophthalmologists are also not infrequently confronted with cases where cataract develops in an eye involved in a glaucomatous process. Cataract may begin to develop at any stage of glaucoma, owing to disorders of the specific metabolism, or it may occur as a commonly encountered senile cataract, being a casual concomitant condition. Cataract developing in the blind eye during absolute glaucoma, the final stage of glaucoma, is indicative of deep metabolic disorders.

According to some published data, lens opacities in glaucoma prevail in the posterior cortical layers and under the posterior capsule.

CATARACT DUE TO TRAUMA

A traumatic cataract may result from exposure to the effect of various forms of energy: mechanical, thermal, electrical, radiation, etc.

Mechanical injury is received through the action of external force to the eyeball. The collision either leaves the eye coats intact, causing contusion, or it ruptures them. Rupture of the external coats only causes a simple penetrating injury, but if the trauma involves the lens, the iris, or the other internal coats, the injury is qualified as a complicated penetrating one. The injuring agent may remain in the eye (as an intraocular foreign body), or may only inflict the wound.

Contusion cataract is a relatively rare occurrence, which is encountered much less frequently than cataract resulting from a penetrating injury.

In a group of traumatic cataracts (about 100 eyes) that we treated surgically during World War II and in the first post-war years, only four could be considered without question as contusion cataracts.

The mechanism giving rise to contusion cataracts, or at least to the appearance of most of them, is not clear and is the subject of much argument. Attempts have been made to attribute their origin to mechanical causes; for example, to imperceptible ruptures of the lens capsule, to chemical shifts (increase in protein content of the aqueous humour of the anterior chamber), to such physical phenomena as disturbed osmotic equilibrium, etc. There is, however, no unity of opinion on this problem, and it remains unsolved.

The mildest form of contusion cataract, Vossius' *ring* or *cataract*, is to some extent an exception because of its relative frequency and clarity of pathogenesis. It is easily seen in transmitted light with the pupil dilated. The ring forms from pressure of the posterior surface of the iris on the anterior surface of the lens capsule during a contusion, and consists of pigment cells and an admixture of blood. This phenomenon soon disappears, as a rule, and only rarely are faintly discernible traces of the ring seen later on the capsule.

A combination of contusion cataract with a cataract complicating a penetrating injury to the eyeball is represented by the form that occurs after massage of the cornea with a blunt instrument. Massage of this kind is employed after paracentesis of the anterior chamber to accelerate maturation of the cataract; perhaps it is better to say that it used to be employed when complete maturation of a cataract was considered indispensable for its extraction.

Cataract from penetrating injuries of the eyeball. The conditions for the rise and development of this type of cataract occur in various ways and depend on a number of circumstances. Contact of aqueous humour with lens fibres is one of them: becoming saturated with the fluid, the fibres swell and turn opaque. The course and development of the two processes vary according to a number of factors: the size of the defect; whether it will close, and if so, how soon; its localization; and the individual peculiarities of

the patient. With very small defects, the amount of fluid escaping to the fibres is slight and only a small part of the lens becomes soaked, so that opacity will be limited to that part only. A small defect has sufficient chance to heal rapidly; penetration of fluid into the lens will then cease, and the opacity will remain localized. Furthermore, in young people and individuals with adequately active defence forces in general, a small opacity may undergo resorption and the lens re-acquire its former transparency. Similar conditions may occur in an eye with a penetrating wound localized behind the iris; the latter will cover the defect and thus prevent transudation of fluid into the lens. The process runs a different course if the capsular defect is relatively large and if, in addition, it lies opposite the pupil; particularly unfavourable conditions are encountered in aged individuals with weak bodily resistance. The cortical substance of the lens swells rapidly and becomes opaque, while its surface layers protrude through the defect into the anterior chamber where they may gradually undergo resorption. In young healthy individuals they may disappear completely, but a nucleus, if already formed, will not become resorbed.

The processes here described usually take a mild course, response to the injury showing in an irritation of the eye varying in intensity. Swelling of fibres within the confines of the eyeball, however, may give rise to a number of unpleasant after-effects, such as an increase in intraocular pressure (secondary glaucoma), or the formation of a secondary cataract. The condition may become even graver if an infectious process occurs, causing inflammation of the uveal tract. This can have unpleasant consequences if the appropriate measures described later are not applied.

The presence of a foreign body complicates the condition, irrespective of whether it is lodged in the lens itself. Iron and copper splinters are disintegrated by electro-chemical processes, and if retained in the eye for a long time particles settle in the tissues, including the lens (predominantly in the subcapsular epithelium), and give rise to a very characteristic picture. Iron causes impregnation with rust (*siderosis*): yellowish deposits are encountered under the lens capsule, the iris turns yellowish-green, and pig-

mentation appears along the periphery of the fundus. Impregnation of tissues with copper particles is known as *chalcosis*. A typical pattern of a sunflower with a greenish-grey brilliance forms in the lens hence its name 'sunflower cataract'. The opacity resembles velvet in appearance, and dots of various colours can be seen over the whole surface immediately behind the posterior surface of the anterior capsule.

Both of these processes present great danger to the eye and require decisive measures for their management.

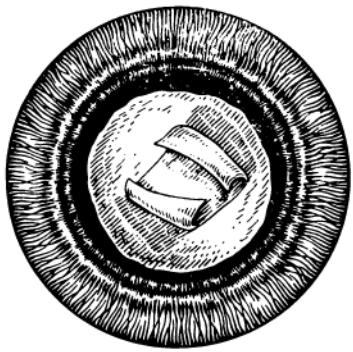


Fig. 9 Heat cataract (separation of the capsule)

Traumatic cataracts also include those caused by the effect of *heat* (*infra-red*) *rays*. They occur in workers exposed over lengthy periods to very high temperatures—glass blowers (*glass blowers' cataract*), smelters and blastfurnacemen, and welders. Examination reveals rounded opacities at the posterior pole of the lens, i.e. right at the site where infra-red rays are focussed. The opacities progress slowly and may spead over the entire lens. It is not always easy to distinguish heat cataract from the senile cataract commonly encountered because the former is most prevalent in workers with a longer work record, and in elderly individuals. Differential diagnosis is sometimes easier by the separation of the lens capsule into zonular and epithelial lamellae which precedes the development of a heat cataract and is clearly detectable by biomicroscopy (Fig. 9).

Cataracts associated with the effects of high voltage *electricity* and of *lightning* are also treated as traumatic. We consider them together here because there is no essential difference between them. The factor responsible for opacity is impairment of lens nutrition resulting from death of epithelial elements following exposure to an electric current. The influence of concussion of the lens also cannot be denied. The latent period preceding the appearance of the opacity varies from several days to many months; opacities are encountered subcapsularly in the peripheral parts of the cortical layer or within the capsule itself at the end of this period. They are generally seen as dots, bubbles, vacuoles, and lines; sometimes the lens resembles pumice. The cataract may be unilateral or bilateral. Having appeared, it may become arrested in its development, or may assume a progressive character and develop into a complete cataract.

Of considerable interest is a case which we observed together with Skvorchevskaya.

E. M., a 16-year-old girl, had been struck by lightning in 1962. Her body had extensive scars from burns. Pathological changes in the eyes were encountered about three months after the accident; separate bubbles arranged in a chain were detected in the deep parts of the cortical layer of the lens of the right eye; no pathology was revealed in the fundus. The number of bubbles increased with time and opacities in the form of grey strips lying radially soon appeared in the periphery under the anterior capsule (Fig. 10). Visual acuity, which persisted within normal values at first, began to deteriorate,

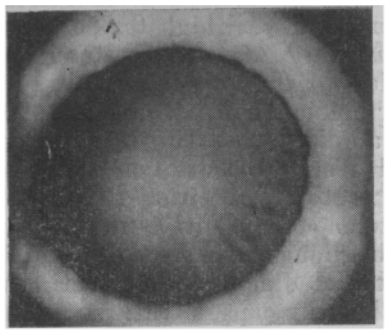


Fig. 10 Lightning cataract (personal observation)

and in September 1963 became as low as 0.02 due to the appearance of a diffuse opacity in the centre of the lens in the region of the pupil. Similar changes were revealed in the left eye about a year later.

Radiation cataract. At one time, this type of cataract was confined to lens opacities caused by X-rays. This conception, however, has had to be extended, and all cataracts resulting from exposure to radiation of various wavelength, from γ-rays to radio waves, and to all forms of ionizing irradiation, are included under it.

Many new facts concerning the characteristics of the cataract itself have been obtained in recent years. It had earlier been considered that the presence of granulations and polychromic iridescence under the posterior capsule of the lens was typical of this type. Similar changes, however, have been encountered in individuals who have not been exposed to radiation, and the incidence of the changes has been found to increase with age. A radiation cataract begins at the posterior pole of the lens in its cortical layers, appearing as aggregations of grey, pin-point densities that grow in size with time and form a spot, a ring, or a disc without clearly defined edges. Vacuoles appear in front of the disc (Fig. 11). The minimal dose capable of causing the development of a cataract is taken to be 200 R. Ra-

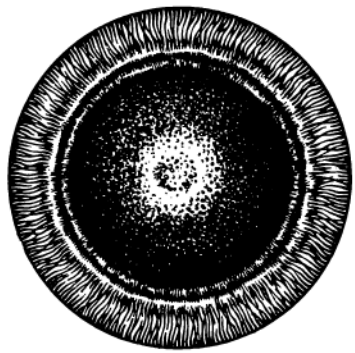


Fig. 11 Radiation cataract

diation cataract has an extremely long latent period, which may last from one to ten years.

Cataract is one of the links in the complex of changes known as radiation sickness, and is encountered in 30 to 40 per cent of the individuals who have suffered from this disease.

The cataract is not always easily recognized since it has no comprehensive typical signs. Diagnosis must be confirmed by anamnestic data (the patient having been exposed to conditions in which he could have suffered irradiation), and by objective findings obtained from examination of other organs.

We have dwelt on a description of the most frequently encountered types of cataract. Apart from the causes mentioned, various others may give rise to opacities in the lens, such as infections, poisoning, nutritional disorders, blood loss, etc. Cataracts of such origin are rare and we shall not deal with them. One type, however, which is still in its infancy, cannot be left unremarked. This is the cataract due to prolonged use (local and general) of ketosteroids, particularly in large doses. This unfavourable side effect of these otherwise valuable agents, which are becoming more and more important, has not yet been fully studied. The observations available, however, give warning of an obvious danger.

CHAPTER 3

DIAGNOSIS

When studying the condition of the lens, we are interested whether it is transparent or whether an opacity, a cataract, is to be seen in it. If the latter is the case, one should specify its developmental stage (whether it is progressive) and type, and determine its aetiology.

There are many methods, mainly visual, by means of which a cataract may be revealed: visualization with the naked eye, examination under lateral and through illumination, biomicroscopy employing a slit lamp and a binocular microscope (or, when these are not available, a magnifying binocular lens and the slit in the electrical ophthalmoscope), photography, and examination under monochromatic light.

Biomicroscopical examination, however, can lead to erroneous conclusions, because even a perfectly healthy lens is not completely transparent; biomicroscopy can reveal the presence of very fine opacities for which there are no grounds to suspect cataract.

Slit lamp examination provides ample opportunity for diagnosis of cataract, and for determination of its location and the extent of the opacities. The depth of the latter is indicated by the zones of discontinuity. Most available data on lens pathology was discovered by just this examination technique, which facilitates determination of the aetiology of the cataract, though not supplying evidence of its precise nature.

The complex of methods employed for studying a cataractous lens includes photography which documents this condition dynamically. Our work 'Secondary Cataract' (1949-61) published seventy paired photographs of secondary cataract, showing the results of membrane extraction.

Studies of lens condition can be supplemented by examination under monochromatic rays. Particularly valuable findings have been obtained by employing ultra-violet rays, mainly with secondary cataract. Elements of lens tissue exhibit luminescence under these rays, while the capsular cells do not; this phenomenon allows structural elements of the membrane to be differentiated and determined. Regenerated lens elements, the Adamyuk-Elschnig's bodies or pearls, the size, shape, and number of which are important when choosing the method to remove them (whether non-surgical or surgical), stand out most.

Of the other monochromatic rays used to examine a cataract, we shall mention only infra-red rays, which permit visualization of internal segments as deep as the retina, even through an opaque cornea.

Negative results yielded by these methods of examination, however, demonstrate only that there are no opacities in the central parts of the lens, examined with the pupil undilated, and are obviously not to be relied on when deciding whether a cataract is present. The fact is, as has already been mentioned, that many cataracts, perhaps most, begin in the region of the equator and cannot be seen if the pupil is not dilated. Therefore the second stage of examination for opacities will involve maximum dilation of the pupil. This is done by instillation of certain mydriatic drugs. The pupil can be dilated in two ways. The first consists in blocking the cell receptive substance in the muscle responsible for pupillary contraction. This effect is obtained by cholinomimetic (parasympatholytic) agents—atropine, homatropine, platyphylline, and scopolamine. The first three are applied in the form of a 1 per cent solution, while scopolamine is used as an 0.2 per cent or 0.3 per cent solution. The other method involves the use of adrenomimetic (sympathicotropic) agents—adrenalin (1:1,000), ephedrine (2 or 3 per cent solution), phenamine, otherwise known as amphetamine sulphate (1 or 3 per cent solution), mesaton (1 per cent solution), and cocaine (1 to 3 per cent solution). These substances stimulate the pupillary dilator innervated by the sympathetic system. Poos (1930) showed that active relaxation of the sphincter occurs. This fact was subsequently confirmed by a number of authors (Velhagen, 1958, and others).

Thorough and detailed examination of the lens requires maximum dilation of the pupil but complete mydriasis cannot always be obtained by separate use of the drugs mentioned. In that case either a summation method or a way of raising the potency of the drugs is employed. The first method involves the use of several drugs similar in effect and in the site of their action; the result of their combined use is equal to the sum of the effects of each ingredient. The second method causes a change in the activity of the drugs by affecting various mechanisms, and its result exceeds the sum effect of the ingredients. The combined use of cocaine and adrenalin is an example of the first method, and the use of atropine jointly with cocaine and/or adrenalin, of the second. Adequate utilization of the pharmacodynamic properties of mydriatics will produce maximum dilation in each individual case.

The mydriatic effect of a drug depends not only on its properties, but also on the way it is administered. The technique commonly employed for cataract diagnosis is instillation (repeated if need be) of any of the solutions into the conjunctival sac.

We have been using a very effective method to obtain maximum dilation over a period of more than 30 years (Rabinovich, 1933). A cotton tampon well soaked in a solution consisting of half 3 per cent cocaine solution and half adrenalin solution (1:1,000) is inserted behind the lower lid and left there for 15 or 20 minutes. In the absence of firm adhesions between the pupillary margin and the lens capsule the pupil dilates to such an extent that only a thin strip of the iris is left, and the entire lens, and even some of the zonular fibres can be well visualized. A similar effect can be obtained by subconjunctival injection of 0.1 millilitre of an 1:1,000 adrenalin solution. This procedure, however, should only be employed in exceptional cases, since its use is unwarranted in uncomplicated cataracts, while with an increase in arterial pressure it is even dangerous.

Maximum mydriatic effect of a combination of drugs can be achieved only if they are mixed in vitro but not in vivo; a prepared mixture of the drugs should be introduced into the conjunctival sac, but not each one separately. This seemingly paradoxical phenomenon, long noticed by us, was con-

firmed in research carried out by Hoorens (1961), who obtained results similar to our own: a combination of cocaine and adrenalin produces a strong effect when a mixture of the drugs is used, a weaker effect when they are administered separately, and a still weaker effect when they are instilled into different parts of the conjunctival sac.

Subconjunctival and parenteral injections made in the variants described yield similar results. To explain these facts, Hoorens advances the hypothesis that a new chemical compound is formed when the drugs are preliminarily mixed, which possesses heightened mydriatic properties.

The question arises, which of the drugs mentioned above should be used to dilate the pupil in any given case.

The approach to this problem must be individual. Younger people (under 30 or 35 years of age) may be given drops of a 1 per cent homatropine solution in the conjunctival sac once or twice. The effect usually does not persist for longer than several hours. If this does not produce sufficient dilation, an effort should be made to gain a better effect by using a stronger homatropine solution (2 to 6 per cent).

We do not recommend atropine for diagnostic purposes. Its advantages over homatropine are insignificant, but the danger of its bringing about an increase in intraocular pressure is greater. Moreover, the mydriasis produced by atropine persists for many days causing discomfort to the patient, either of an optical character if the visual acuity in the examined eye is not impaired, or of a cosmetic character if there is a cataract.

Mydriatics should be used with caution in individuals over forty years of age and should be administered only after tonometry has shown that the pressure in the examined eye does not exceed normal values, and when anamnestic data provides no evidence of glaucoma (at the time of the examination the process may be compensated, intraocular pressure normal, and other symptoms of the disease may be absent). Atropine, scopolamine, homatropine, and platyphylline, i.e. substances that increase pressure, are not recommended for these patients under any conditions. Use of cocaine should also be considered with great care, because it too raises pressure though lesser than the afore-mentioned drugs. Administration of cocaine alone should definitely be avoided;

it may be applied only in combination with adrenalin in the recommended form, and even then only after drugs that do not increase intraocular pressure have proved ineffective. These drugs are a 2 or 3 per cent solution of ephedrine or phenamine, adrenalin (1:1,000), and 1 per cent mesaton solution. Their mydriatic effect, however, occurs later than that of those mentioned above, and is not always sufficient; when employing them, therefore, advantage should be taken of the summation phenomenon, and adrenalin combined with ephedrine or phenamine. Adrenalin, it should be remembered, may be used in simple glaucoma without fear of increasing the intraocular pressure, because it does not have this effect with this form of the disease and is even prescribed as a therapeutic measure.

When examination with a dilated pupil has been completed its initial condition should be restored, i.e. the pupil should be narrowed, firstly so as to prevent a rise in intraocular pressure, and secondly, to remove any visual or cosmetic hazards. An exception may only be made with children. Constriction of the pupil with a simultaneous reduction of intraocular pressure is best produced by a 1 per cent pilocarpine solution; the patient should be warned in advance that the miotic may cause a temporary unpleasant sensation in the eye and in the region of the orbit.

Examination with a dilated pupil reveals the localization of the opacity and the extent of its spread, and helps to determine the degree of maturity of the cataract. Comparison of these findings with the visual acuity of the affected eye, and with the degree of visual impairment due to the cataract, yields the answer whether treatment is feasible and necessary, and if so, in what form should it be applied.

An early, though indirect, inconstant, and by no means pathognomonic symptom of incipient cataract deserves mention. This is an increase in ocular refraction—a change from hyperopia to emmetropia or even to myopia, and from emmetropia to myopia, or an intensification of myopia. This phenomenon is due to biochemical shifts occurring in the lens during cataractous degeneration, owing to its swelling, which causes an elongation of its antero-posterior axis. This phenomenon is responsible for the fact that individuals with weak presbyopia do not wear glasses, while those

suffering from a higher degree of presbyopia change from stronger ones to weaker.

Having determined the presence of a cataract, and acquired sufficient data on the morphology of the opacity, we must decide whether it is stationary or progressive. The answer to this question is often facilitated by the morphological features of the cataract, supplemented by anamnestic data (impairment of vision, etc.), and by a dynamic follow-up of the lens condition in cases with a vague clinical picture.

With a progressive cataract we must establish its stage of development and maturation.

The division into stationary and progressive cataracts has proved quite justified on the whole, and feasible. Stationary cataracts, however, may sometimes become progressive owing to the effect of endogenic (diabetes or other endocrine dysfunction) and exogenic (trauma, etc.) factors.

Examination of the lens, particularly when made by an inexperienced physician, can lead to erroneous diagnosis of cataract. This is due to the fact that the lens nucleus undergoes sclerosis with age, loses some of its transparency so that some of the rays falling on it are reflected; the pupil therefore seems grey, and simulates a cataract. On examination under through rays, however, the usual red reflex appears, though rather dim. The decrease in visual acuity is slight, which together with other symptoms helps to differentiate between cataract and sclerosis.

A few words should be said about the 'black cataract' encountered in very old people. Strictly speaking, it is not a true cataract, but a pseudo one. No opacities form in the lens, but it turns dark-brown, sometimes even almost black. Pupil reflex is pale-red, and visual acuity becomes severely impaired because most light rays are absorbed by the lens and do not reach the retina. While sclerosis of the lens can be conditionally considered a physiological, or in any case, a natural process, 'black cataract' should be acknowledged as a pathological phenomenon. It is attended by a severe nutritional disorder of the lens, the character of which has not yet been completely defined. It would seem to be associated with disintegration of molecules of lens protein, one of the products of this process, tyrosine, probably being converted to melanin.

CHAPTER 4

INDICATIONS AND CONTRAINDICATIONS FOR TREATMENT

Until fairly recently, indications for cataract treatment implied indications for surgical intervention on the affected eye. Time and the progress of science have made two corrections to this proposition. Firstly, the current conception of the integrity of the body no longer permits us to speak of the treatment of a disease or of separate organs or systems, but only of producing a therapeutic effect on separate structures, primarily on the sick organ, by causing an effect on the body as a whole, while not neglecting at the same time the possibility of exerting a direct, local influence on the affected organ. Secondly, the advances made in medical science have allowed successful non-surgical management of a cataract at certain stages of its development, an operation being performed only when the former has no chance of success.

It is not feasible to divide the indications and contraindications and discuss them separately. Therefore they will be presented together here.

Galen pointed out in the second century that a cataract may be resolved at the beginning but not later. Since his dictum referred to medicinal treatment we may assume this course to be indicated for the incipient stage of any type of cataract.

Two points, however, need to be borne in mind when considering the feasibility of medicinal treatment. As we have already mentioned, we have the right, when employing modern therapeutic methods, to expect development of the cataract to be arrested, or at least suppressed, and sometimes, even its partial involution. This can happen if the replacement of the soluble proteins by insoluble is prevented,

and resolution of the opacifications of the soluble ones is stimulated.

From this approach, congenital and stationary cataracts are not promising as regards possible involution of the opacity. If the opacities do not impair visual acuity to such a degree that surgery becomes necessary, then non-surgical treatment is indicated under all conditions. It will not, in any case, cause deterioration, while some chance of improvement will always exist. If it is seen, however, that the desired results cannot be obtained, then surgery should be considered; the indications for it will be considered later.

It is rather different with non-surgical treatment of progressive acquired cataracts, which are usually senile. Therapy is always indicated for such conditions, and can be expected to yield good results when applied at an early stage.

We do not, however, imply that systemic and local treatment is quite pointless with developed cataracts. Experience, our own in particular, has shown that even developed cataracts may undergo partial and complete involution. The involution may occur at various periods of time, from several months to several years, and not solely under the influence of effective modern therapy but even spontaneously. About eighty cases of involution of senile cataracts (this refers, of course, to intracapsular resolution with the capsule intact) have been described in the literature. Involution may occur without any reaction or may be the sequela to an acute inflammatory process, e.g. anterior uveitis, or an attack of glaucoma. It is quite clear what factor facilitates resolution of the cataract during the treatment; the mechanism of the therapeutic effect is discussed in Chapter 5. The cause of spontaneous resolution is not yet clear, and there are only hypotheses with regard to it. Some authors hold that it is due to the effect on the lens of proteolytic enzymes which cause liquefaction of the lens and thus facilitate resolution of the cataract. Other authors suggest that spontaneous resolution is a natural terminal stage of the cataractous process, and that we encounter only an insignificant number of instances of this interesting phenomenon because few patients live to reach this stage.

We present a brief case-history of a patient we observed

many years ago. Medicinal management of cataracts was then at its embryonic stage, and was prescribed, strictly speaking, so as not to deny all treatment to a patient but to leave him some hope. Endeavours to facilitate resolution may rightfully be characterized by the expression "attempts employing useless measures" because the measures then used (over 50 years ago) were, in truth, useless and comprised iodine preparations (potassium or sodium iodide) administered per os or locally in the form of drops or unguents.

B. K., a 51-year-old male, developed senile cataracts on both eyes almost simultaneously. They progressed with the usual rate and vision gradually became impaired. When the cataracts reached their second developmental stage and visual acuity fell to 0.2-0.3, the patient was recommended further treatment and we temporarily lost contact with him. About six months later he returned and we found that almost all lens opacities had resolved and that the visual acuity of both eyes was 0.7-0.8!

It should be stressed that the affected lens fibres had not resolved, but they had become clear and their transparency had been restored. It is difficult to say what factor was responsible for this process, the treatment or *vis medicatrix naturae*, for we must not forget Hippocrates' wise dictum—*medicus curat, natura sanat.*

Frandsen (1965) describes a similar case of spontaneous resorption which he puts down to over three year's treatment with prednisolone. We ourselves employ the following tactics, which we consider the most adequate: we prescribe complex non-surgical therapy for progressive unilateral or bilateral cataract, making an exception only when the cataract has developed to the stage where it can only be managed by an operation. With a mature cataract in one eye and a less developed one in the other, we continue systemic treatment and apply topical drugs only to the less involved eye.

When considering the indications and contraindications for cataract extraction, as for any operation on the eye, three moments should be borne in mind:

(1) the condition of the eye to be operated on: its nutrition and intraocular pressure, and the concomitant pathological changes, if any; the peculiarities of the disease responsible for the operation (of the cataract in the given

case): its aetiology, pathogenesis, type, and degree of maturity;

(2) the condition of the other eye, in the first place its functional value, and then its possible influence on the postoperative course, etc.;

(3) the patient's physical condition and state of health, occupation, living conditions, age, etc.

Some occupations, involving the reading of fine detail, e.g. draftsmen, designers, precision fitters, laboratory workers, etc., require sharper vision than others. The indications for an operation vary correspondingly with occupation to occupation. A certain role is also played by the patient's age: a young man with a long future before him requires better vision than old age pensioner; this fact should also be considered when deciding whether to operate.

The presence of contraindications due to systemic conditions should be ascertained by consultation with specialists in internal medicine, neurology, etc., taking the patient's complaints into account. Continuous follow-up on his general condition is also necessary.

An absolute contraindication for cataract extraction, dictated by the patient's physical condition, strictly speaking, is a very short life expectancy.

All contraindications of a general nature may thus be considered relative, and should be strictly individualized with each case. Identical pathological changes may have weight in one case and present no obstacle to operation in another. The significance of any deviation from the normal physiological state needs to be judged in the light of the general physical condition of each individual patient.

Age, as such, is not a contraindication. Small children should be anaesthetized for operation as they are apt to become restless. Children with bilateral cataracts need to be operated on as early as possible, bearing in mind that vision depends upon the adequacy of all the links of the visual analysor, particularly on the degree of the development of the receptor, i.e. the eyeball and the higher divisions of the brain. There is a two-way functional connection between these structures; development of the brain and its functions is closely connected with the development and function of the eye, and vice versa. It is clear, therefore, that bilateral cata-

racts impair the vision and exert a harmful influence on the child's development and behaviour, and on its vital activity in general. The brain, particularly its higher divisions, the conducting pathways, and the visual pathway are poorly developed in the newborn. The adjusting eye movements of an infant watching a light are reflexes. All this points to extraction of complete bilateral cataracts as early as possible, if the child's physical condition permits, of course. The yellow spot functions poorly in infants; those under two weeks have only hypothalamic vision as only the periphery of the retina functions.

By the fourth month of life changes occur when the yellow spot begins to function much better. Early operation can then prevent the development of nystagmus.

From these considerations we may conclude that extraction of complete bilateral cataracts should be performed within the first months of life in at least one eye, and whenever possible in both.

We have performed many operations on elderly patients, and cannot remember a single case when advanced age exerted any harmful influence on the operation itself or on the postoperative period. Extraction, being a serious procedure in itself, and in its postoperative course (healing of the incision and formation of the anterior chamber) has a specific character in the old, of course, which must be known and taken into consideration when surgery is resorted to. This specific feature consists in a hard nucleus and a rigid iris.

Any acute disease, or any non-compensated systemic impairment in the body is, naturally, a temporary contraindication. Once the acute period subsides, or the pathological condition becomes compensated, it is possible to operate with due consideration to the patient's condition and to the nature of the cataract (diabetic, heterochromic, etc.).

Whether to operate on debilitated or marasmic patients, or on mental defectives, must be decided individually in each case, weighing up the pros and cons.

The condition of the other eye is also a factor. There is no need to operate on the affected eye if the normal one has good visual functions and high visual acuity, and the patient can work without handicap, the more so since bin-

ocular vision will only be possible under certain circumstances because of the big difference in refraction in each eye (a point we shall consider later). Opinions on this, however, differ and there are two distinct trends. One group do not regard high visual acuity of the healthy eye as a condition hindering or contraindicating extraction on the other; they operate considering that the eye so treated will help improve central vision and extend the field of vision. The other group, to which we adhere, holds the opinion that surgery is not recommended for optical reasons: the improvement anticipated is insignificant and generally outweighed by the discomfort the patient suffers owing to the difference between the refraction of the eye operated on (aphakic) and of the other with high visual acuity. The patient's age, occupation, physical condition, and other factors, of course, should also be taken into account. An exception are young individuals with traumatic cataracts: an operation has to be made even with high visual acuity in the other eye, because it may retain good vision throughout life. We consider that extraction of cataract is indicated when visual acuity in the other eye is less than 0.4, since vision in the aphakic eye after correction may as a result of successful operation exceed the visual acuity of the other eye to such an extent that the image formed in the latter will be suppressed and will not cause discomfort.

One of our cases illustrates this.

M. B., a 68-year-old pharmacist, had a mature senile cataract of the right eye; visual acuity of the other eye was 1.0. Although the patient insisted on an operation, we flatly refused to extract the cataract, giving the reasons dwelt on above. Nonetheless the patient persuaded another surgeon to operate. With correction, vision in the aphakic eye increased to 1.0, but due to optical discomfort the patient was unable to use both eyes simultaneously and had to keep one covered.

Thus, with no impairment of function in the fellow eye, the indications for operation are considerably limited and are mainly of a cosmetic nature. Low vision in the second eye, on the other hand, particularly when there is no hope of improvement, strengthen the indications for extraction of cataract; but the cause of the blindness should be

thoroughly analysed. We may illustrate this by an example. Atrophy or subatrophy of the eyeball, hypotonia, easy irritability, and other pathological conditions at the eye revealed by medical documentation or information supplied by the patient, and confirmed by examination may indicate that the patient had suffered sympathetic uveitis in the past and that the condition persists in a latent form. They are a sign of the potential danger of a flare-up due to some factor, to any intercurrent disease or, particularly, to a trauma, which includes surgery. Such an eye must, without question, be enucleated before a cataract is extracted from the other. In spite of the many reports in recent literature on the valuable therapeutic effect of non-surgical measures on sympathetic uveitis, in no circumstances do we recommend to leave the eye in situ and depend on non-surgical treatment.

The main factor to be considered when deciding whether to operate is the vision in the affected eye. Operation is indicated if visual acuity is within certain conditional limits, otherwise it is not recommended; with vision below the lower, minimal limit nothing is to be gained by operation, while, with the vision above the upper, maximal limit, it is unnecessary.

We emphatically caution against extraction of a cataract from a permanently blind eye, that is, when blindness is not due to accidental temporary factors (e.g. haemophthalmos, etc.) but is caused by irreversible pathological changes, such as atrophy of the optic nerve, extensive inoperable retinal detachment, etc., diagnosed from medical documentation or anamnestic data. Before deciding to operate, one must determine whether the blindness is absolutely hopeless, or whether it is conditional and vision restorable. In the first case operation will only serve cosmetic purposes, and its results are rarely successful.

Among the several thousand cataract extractions made by us, none were performed on a blind eye for cosmetic purposes. We became firmly convinced of the riskiness of this procedure after witnessing the following accident. A highly qualified ophthalmologist was persuaded by a young woman to perform extraction of a complicated cataract (secondary glaucoma attended by very high intraocular

pressure). After a skilful incision had been made, the lens actually blew out of the gaping wound followed by escape of the entire eye contents. As a result of this unfortunate operation the eyeball shrank to the size of a small cherry.

Let us return to the question of the limits of visual acuity mentioned above.

For long the lower limit (that determining the minimum visual acuity), at which an operation of an optical character aimed at improving vision was indicated, was taken as the existence of photoperception of correct light projection, ascertained by the conventional method (examination under the rays of a 60 watt electric bulb, reflected from the ophthalmoscope, the eye being illuminated successively from above, below, and the sides). If the patient gives uncertain answers during this examination and doubt arises on the presence of correct photoperception, another method may be used. The examination is repeated several times, but before each illumination the patient is told to close his eye for ten or fifteen seconds so that the retina can rest and produce a new response to a new stimulation. Our experience has shown this method to be valuable. The patient's answers, on which evaluation of the postoperative results to be expected much depends, are more precise and, undoubtedly, more correct.

Examination by light reflected from a lamp, however, is not precise enough. The eye is illuminated by a relatively bright ray, and therefore even severe impairment of photoperception, in the retinal periphery in particular, may not be detected. For that reason we recommend a more precise method. With the other eye tightly closed, the eye to be operated on is illuminated from a distance of five or six metres by a weak light (a pocket flashlight, an electric ophthalmoscope, or a candle) successively from the front, and sides, and from above and below. The patient, with his gaze fixed straight ahead, should state accurately and clearly from which direction the light is falling. Only in this way can the light projection be assumed correct.

A very accurate and skilful study of photoperception can be made using a localizer, an apparatus with a controlled light source whose parameters (brightness, angle, colour, duration, and positioning) are known to the examiner and

can be altered by him as desired. With this apparatus, one can determine the boundaries of the preserved field of photoperception, reveal capacity to perceive differences in brightness, etc.; in other words, one can obtain an accurate idea of the condition of the visual functions, which is essential, particularly, if they are severely impaired.

Comparison of the findings obtained by examination by means of a weak light source (e.g. a candle) at a distance of five metres, with an ophthalmoscope at a distance of fifty or sixty centimetres on the projection perimeter, and, lastly with a localizer has shown that the last yields the most reliable data.

Mention may be made of Gramberg-Danielsen's proposal (1959) to verify the correctness of light projection by means of X-rays which are absorbed and perceived by a healthy retina under certain conditions and produce no pathological response in the retina (detachment, atrophy, degeneration, etc.). He considered the test to be very accurate and sensitive. According to Avakian (1960), an eye adapted to the dark is capable of perceiving X-rays even at 0.0004 R.

Some authors are of the opinion that X-rays cause direct stimulation of the visual receptors, while others think that they are responsible for fluorescence of retinal microelements which stimulates the receptors.

The method of examining retinal function by producing the "light phenomenon" and studying "X-ray vision" deserves attention. It is based on the ability of an eye adapted to the dark to perceive X-rays independently of the state of the optical media, and consists in the following. An object impenetrable by X-rays is placed before the eye examined; with preserved visual function this object will be perceived by the retina as a dark image on an illuminated pale-blue or yellow background. The results obtained by this simple safe method point to its expedience.

A combined method used for studying the functional state of the visual analysor consists of the following procedures: examination of the field of perception under light reflected from an ophthalmoscope, under candle light at a distance of five metres and under the light of a localizer; studies of the electrical sensitivity of the eye and of the

swiftness of its reaction by means of an electronic stimulator; electroretinography; electroencephalography. According to the published data, this method yields the most correct information on the state of the nervous system of the eye.

A strict approach to evaluation of eye capacity to perceive and project light is warranted to some extent by clinical practice; eyes that have perceived rays uncertainly or incorrectly when examined by precise methods, have indeed not infrequently proved inadequate after removal of the optical obstacle (cataract extraction, for example).

It must, however, be said that even with negative, and especially with doubtful findings from examination, operative treatment should not always be abandoned. The patient should then be warned that the prognosis with regard to vision raises doubts even if the operation were completely successful.

The position with regard to the significance of photoperception and light projection has changed completely of late. Contrary to earlier views, impairment of light projection is no longer considered an irreversible condition. It may only be seemingly so, being caused by suppression of functions in a stuporous eye, and vision may be restored with disappearance of the reversible pathological change. Sometimes only time is required, other things being equal; thorough local and general treatment, of course, gives even better chances of a successful outcome.

It has been shown that potentialities of improvement may be encountered not only in eyes with temporary loss of photoperception, but even in those suffering initial atrophy.

Thus far we have dwelt on the contraindications for cataract extraction associated with deficiency and impairment of visual functions in the affected eye. We shall now draw our attention to a number of contraindications connected mainly with functional disorders of a secondary nature.

The presence of leucoma of the cornea, which may, by localization, thickness, extent, etc., obstruct vision following a successful cataract extraction, is an absolute contraindication. A joint decision must then be reached on the management both of the cataract and of the obstacle pre-

sented by the cornea (e.g. iridectomy, corneal transplantation, etc.).

The presence of anterior synechiae stresses and reinforces indications for operation, particularly if the leucoma presents no optical impediment. Anterior synechiae should not by any means be regarded as innocent and harmless structures not requiring attention. Sooner or later, they may be responsible for various pathological changes in the eyeball and, even important, for secondary glaucoma. It can be said with confidence that their division has a favourable effect on the condition of the eye.

Secondary glaucoma is a frequent concomitant condition of a complicated cataract. It may result from atresia iridis, impairment of fluid filtration through the angle of the anterior chamber, etc. The condition reinforces indication for extraction.

Retinal detachment is encountered less frequently but is probably the gravest concomitant condition, and requires both a special approach to the operation and exceptional care during its performance. Retinal detachment is known to have been caused by the operation itself (owing to lack of care in handling the iris, severe injury of the vitreous body, etc.), and for this reason its presence naturally requires thorough analysis of all factors for or against surgery. Since a surgical procedure can cause detachment of the retina, it may augment a detachment already present, changing a partial detachment to a complete one, and depriving the patient of what priceless diminished vision had remained. Extraction of the cataract is conditionally indicated in such cases, and is recommended only if the second eye is absent or if its condition is hopeless. Our experience indicates that operation is permissible and can produce fair visual and even anatomical results if the procedures are conducted with due precautions. After extraction of the cataract, moreover, one may examine the condition of the retina as a whole and of its detached part, which is of great importance when the possibilities of successful management of the detachment come to be considered.

Finally, we would say a few words about the indications for operation associated with the condition of the lens

itself, namely, with its maturity. It used to be a common opinion that an immature cataract should not be operated on, and only a very few ophthalmic surgeons ran the risk of extracting one that had not matured completely. The reluctance to operate on an immature cataract is explained by the fact that transparent lens fibres could not be seen during extracapsular extraction, the only technique then used, and could be left in the eye, causing such complications, as phaco-anaphylactic endophthalmitis, secondary cataract, etc., and all their consequences. The development of intracapsular extraction has brought about a change in approach to surgical treatment, and specialists have become less strict about their maturity. A certain restraint, however, was encountered to begin with and only a relatively small group of surgeons began to use a forceps for intracapsular extraction of the lens, in case of an immature cataract also. We were among the pioneers of this method (1933). The restraint was soon dispelled with spread of the use of the erysiphake, and of the cryoextractor in particular; and now the stage of maturity is not of great weight as an indication or contraindication for extraction.

CHAPTER 5

PREVENTION AND NON-SURGICAL TREATMENT

The prophylaxis and treatment of cataract are discussed together in this chapter because they cannot really be separated. If we consider both these concepts carefully we are bound to conclude that when we use preventive measures we treat potential diseases, while therapeutic measures at the beginning of any disease prevent its further development and the occurrence of possible complications. The problem will be considered from this aspect.

Our knowledge of cataract is still not sufficient to let us speak of true control. In other words, when discussing the problem of preventing both congenital and acquired cataracts (especially the former), we can only speak of measures that reduce the chances of cataract forming.

PREVENTION

Prevention of congenital cataract is a relative concept. Since the cataract is congenital and the infant is born with an impairment of lens transparency already existing, control measures will also serve a therapeutic purpose in the sense above, i.e. they will prevent further development and progression of the cataract. Most congenital cataracts occur in association with other developmental anomalies and are hereditary so that control is limited to measures contributing to the health of the parents before birth, and to prevention and treatment of toxic and infectious diseases in the mother during pregnancy. If, in despite these precautions, the infant is born with a cataract, its eyes must be kept under constant observation because a stationary cataract can change to a progressive one under the influence of various endogenic and exogenic factors; if that occurs,

the corresponding measures should be applied immediately to control and treat the condition.

That, however, is not so with acquired cataracts, where the approach must vary with the type of the cataract.

Senile cataracts occur at the age of forty and over. For that reason preventive measures, strictly speaking, or at least some of them, should be adopted from that age (for example, administration of vitamins as a general measure and locally).

Prevention of cataracts due to endocrine disorders should be begun as soon as the principal disease has been recognized, whatever the patient's age. If a cataract forms, the measures should be continued; they may then be regarded as both prophylactic and therapeutic in character. Non-surgical treatment should be carried out systematically, right to the time when it proves ineffective and surgery is considered.

Control measures aimed at preventing the occurrence of complicated cataracts should be taken in all diseases that may be complicated by opacification of the lens, and should be as timely as possible. With the appearance of a cataract they also become both prophylactic and therapeutic in nature.

We shall first discuss the measures recommended for true prophylaxis, that is to prevent the occurrence of cataract. They may be divided into general and local. The former, in turn, are divided (a) into measures of a universal character that can, and should, be applied to individuals predisposed to the development of cataract, and (b) into measures of a more direct and specialized action, their character being indicated by the patient's age, occupation, general condition, complaints, etc.

The measures we call universal are rather vague in character and difficult to define precisely. They may be said to be of a general hygienic character aimed at improving the patient's physical condition and at creating physiological conditions favourable to the organism, eliminating harmful factors, regulating working conditions, nutrition, rest, etc. In that way, the hazard of biochemical shifts giving rise to lens opacities is considerably reduced and even minimized. It may still be too early to speak of success

through employing these measures, but attention needs to be drawn to their promising and beneficial effect and, hence, to the desirability of using them.

In Chapter 2 it has already been pointed out that the classification of cataracts by aetiology is far from perfect, but nevertheless has a basis. However incomplete our information on aetiology, the application of general measures to prevent cataract can be considered prophylactic, and to a certain extent, pathogenetic.

Several examples may make this clear.

As stated earlier, rudiments of senile cataract may be encountered in most elderly and aged people. Bearing this indisputable fact in mind, the condition should be regarded as a sign of advanced age. Consequently, prevention of senescence (prevention of its physiological and pathological variants, to be precise) should have a beneficial effect; this benefit with regard to ageing is evident. For example, the expectation of life is now 70; but we do not yet know whether the rise in expectancy has affected the curve shown in Chapter 2 (see Fig. 3); inductive reasoning, however, gives hope that it will be corrected in the near future, and will show that the cataract is yielding ground.

Let us consider another example. The therapeutic and prophylactic measures employed with diabetes should undoubtedly lead to a decrease in the incidence of the cataract associated with this complaint.

The same line of reasoning is applicable to other types of cataract. Thus the general measures to prevent accidents diminish the danger of eye injuries and in that way reduce the incidence of traumatic cataracts caused by them; the protective measures taken for those working with ionizing substances protect them against the development of specific radiation cataracts, etc.

Nor should we ignore the fact that the liquidation of wars, those "traumatic epidemics", as Pirogov called them, would be a truly universal mass prophylactic measure against traumatic cataract.

Local measures of prevention are based on the principle that the organ of vision should constantly be provided with suitable physiological conditions, in other words, that visual hygiene should be observed.

Mention should be made of yet one further fact, to which, is seems to us, ophthalmologists pay insufficient attention. The creation of suitable physiological conditions for the vital activity of the whole body and of its separate organs, as we said before, and especially for the organ of vision, is of prophylactic importance. Among the factors that play a certain role in this respect is the correction of refraction errors, where they exist. We consider it another argument in favour of compulsory correction of refraction errors; we ourselves insistently recommend patients to wear glasses, taking their individual circumstances into account, of course. We would not assert that correction of refractive errors is a measure of cataract prevention, but the fact that it plays a certain role cannot be categorically denied.

We are not alone in this opinion. Bellows (1944) writes that "the use of proper glasses to eliminate refractive errors is believed by some authors to be an important measure in the prevention of cataract (*senile.*—M. R.)". Similar information is supplied by Duke-Elder (1945).

NON-SURGICAL TREATMENT

Recognition of the aetiological factor influencing the formation of opacities in the lens is essential for successful treatment of cataract, and determines the nature of the treatment to be prescribed. If the factor responsible has ceased to operate (congenital developmental anomalies, for example), then the general treatment is confined to the use of tonics and invigorative agents, treatment of predisposing conditions and potential foci of infection, etc. If a permanently active cause of cataract is present in the body, and particularly if the cataract is progressive (e.g. in diabetes, tetany, etc.), the position is different. These "harmful factors" must be recognized and removed whenever possible.

Non-surgical treatment of cataract though still in its infancy, seems most promising and hopeful. The facts at the disposal of ophthalmologists indicate that these hopes are beginning to be justified.

A great many methods and drugs have been proposed for this form of treatment. Most reflect the conception ac-

cepted at the time of their proposal; others are of a casual character. There is no need even to mention many of them since they became obsolete with the conceptions that gave rise to them. We shall dwell only on the complex methods based on the current conceptions of pathogenesis.

From that it stems that the therapeutic effect should be directed against any general pathological changes present in the body and against disorders of a local character, i.e. against pathological processes occurring in the eye itself.

We have already stressed the unity of prophylaxis and treatment. That unity permits us to discuss prophylactic and therapeutic measures together because they have so much in common and are almost identical.

Prophylactic measures are aimed at increasing bodily resistance and improving lenticular metabolism, relieving its respiration in particular; the therapeutic measures used when a cataract has already formed are also aimed at stimulating resorption of the opacities, restoration of transparency of the lens fibres, and improvement of metabolic processes. As a matter of fact, the last two are inseparable; there is no doubt that improvement of metabolism contributes to the resorption of the opacities. The idea occurs involuntarily, that there is perhaps a reciprocal connection between them, and that resorption of the opacities may also stimulate the activity of the metabolic processes.

These aims may all be achieved by improving the physical condition of the body, by bringing the systems and organs to their physiological state, and by rendering harmless all pathological foci and potential sources of various harmful agents.

Therapeutic measures should above all have an effect on the central nervous, cardiovascular, and endocrine systems, and should also remove such harmful influences as the conditions resulting from allergies, etc.

All measures should be prescribed strictly individually, being aimed at affecting the weak spots of the patient's organism. Thus some patients may require regulation of the functioning of the central nervous system, while others need their arterial pressure to be brought to normal,

their general tone increased, endocrine functions influenced, and the body desensitized, etc.

We give particular attention to the state of the central nervous system, its functioning can be regulated in many ways. The method of reinforcement (by increasing the potency of the drugs or by the summation of their effects) is extremely effective; it consists in the combined prescription of several drugs with an identical effect but acting upon different sites (e.g. the brain cortex-subcortex-vegetative nervous system, etc.). They include tranquillizers (sedativa): pantopon, morphine, promedole, bromides, barbiturates, andaxin (meprobamate), etc. We particularly recommend the use of a mixture of bromide and caffeine given in combination with an infusion prepared from Herbae Leonuri, which helps to maintain a balance between the two principal processes of nervous activity, excitation and inhibition. The second signalling system is a powerful tranquillizer and is used correspondingly (which will be discussed in detail in the section dealing with preoperative management of the patient).

Treatment with intramuscular injections of a 2 per cent novocain (procaine) solution (in a dose of five millilitres with ten or twelve injections per course) has become popular and is now widely used. Novocain is responsible for certain shifts in the body which are signs of a peculiar "rejuvenescence": an increase in the general tone and diminution of sclerotic changes and other symptoms of ageing. It intensifies inhibition processes in the central nervous system, causes a shift in the formed elements of the blood, and stimulates the adreno-pituitary system which plays an important role in the maintenance of good health. Instead of intramuscular injections of novocain intravenous injections of a 0.5 per cent solution (five or eight millilitres are introduced every two or three days, a total of ten injections per course) may be given, their effect being similar.

In individual cases, when insufficiency of adreno-pituitary activity is suspected, the use of adrenocorticotropic hormone or cortisone (or one of its analogues) is indicated; aspirin, amidopyrine, butadione, rheopyrene, and other drugs that render a similar effect are also recommended. These preparations, dimedrol (diphenhydramine), belladonna,

pipolphene, and suprastine, and, autohaemotherapy produce a desensitizing effect and are used in allergy (in apparent or inapparent forms).

Vitamins are of paramount importance in complex therapy. The indications for their prescription are not limited to vitamin deficiencies; because of their pharmacodynamic properties, they stimulate vital processes and wound healing, and have caused an anti-infective effect. Owing to their valuable synergistic property, most vitamins should be prescribed in combination; a particularly beneficial effect is produced by those of the vitamin B complex as well as by vitamins C, K, P, PP, and E given in combination with vitamin A. Since vitamin therapy has become widely accepted, there is no need to substantiate its use in cataract. We shall only single out ascorbic acid since it exerts a certain specific effect that is very important for lens opacities: it penetrates the anterior chamber comparatively easily where its concentration in the aqueous humour becomes quite high (higher than in the blood); it should also be noted that penetration of ascorbic acid into the anterior chamber is stimulated by nicotinic acid.

Particular attention should be paid to the management of atherosclerosis, typical of the aged. It is not our intention even to present a rough scheme of treatment; we should like only to point to the efficacy of oxygen therapy, peroral administration of the full vitamin complex, particularly of vitamins B_2, B_{15}, PP, and E, iodine preparations, and dietotherapy.

All pathological processes occurring in the body, of course, are attended by tissue hypoxia. The lens in which opacities have formed, or are forming, is no exception. Therefore, it is efficacious and desirable to intensify its oxygen supply. Of the several ways of doing this, we prefer two: by acting on the entire body through general application, and by affecting the sick organ by local administration. The method generally accepted of inhalation in an oxygen tent or through an inhaler (used in various diseases accompanied by hypoxia) produces a rapid but short-term effect, the blood oxygen content returning to its initial level soon after the procedure is discontinued. Because of that, not a great deal can be expected from this

method. Rectal introduction of oxygen would seem to be a more promising method; it has been shown that it is absorbed at a rate of 0.11 millilitre per square centimetre of intestinal surface per hour on being introduced into the large intestine. Simple calculations indicate that the body (tissues and blood) will be supplied with additional oxygen for several hours when 600 or 1,000 millilitres of the gas are introduced into a large intestine whose surface measures 130 to 140 square centimetres. This calculation has been shown in clinical practice to be correct; at our request Dr. Yu. Printsev conducted an X-ray follow-up of several patients treated by this method and found that oxygen persisted in the large intestine for four-and-a-half to five hours after it had been introduced.

The purpose of so-called local treatment (it would be more correct to speak of local administration of the drugs or of local effect) is identical with that of general. The choice of drugs to be administered directly into the eye either by instillation into the conjunctival sac or by electrophoresis is dictated by the following considerations. The formation of opacities in the lens is associated with biochemical shifts that are occurring, or have already occurred, in its tissues. There are serious grounds for assuming that medicines and preparations mentioned in the next paragraphs are capable of inhibiting the development of these shifts and, in all probability, of neutralizing their harmful effect.

Among the drugs employed, because of their resolvent action, to treat cataract iodine has been used the longest, although only insignificant amounts penetrate the lens after its introduction in solution into the conjunctival sac or by electrophoresis. Not infrequently, iodine is combined with calcium chloride solution.

Local applications of vitamins have become very popular in practice of late. The following considerations underlie this method. The formation of opacities is obviously associated with disorders in the tissue respiration of the lens due to an insufficient supply of energy from the oxidation-reduction processes. The oxygen of the tissue juices, the blood plasma, and the aqueous humour, and also vitamins (riboflavin and ascorbic acid) play the main role

in them. The production of aqueous humour, one of the energy sources, decreases during the initial stages of cataract. According to Nesterov (1965), the decrease takes place parallel with the progression of lenticular opacification. It is dangerous, however, to increase the flow of aqueous humour to the involved eye artificially, because that may lead to a rise in intraocular pressure, a tendency which is already present, especially when the lens begins to swell. Therefore it is more expedient to improve the composition of the aqueous humour than to increase its amount, by adding nicotinic acid (vitamin PP), which stimulates the secretion of vitamin C into the aqueous humour, to solutions containing ascorbic acid. Glucose is also a quick source of energy.

The results obtained by local administration of the drugs mentioned above are extremely encouraging. Our own systematic follow-up (covering a period of twelve years, preliminary results of which were published in 1956) of several hundred patients suffering from various types of cataracts and treated locally with solutions of vitamin-complex at different stages of the disease, as well as the numerous data published by others, permit us to state confidently that these drugs exert a valuable preventive and therapeutic effect, which is best displayed in incipient cataracts. With their systematic use (in combination, of course, with general treatment) we have every right to expect that the development of opacities will be arrested for a long time; moreover, the treatment will contribute to the resolution of some of those opacities that are formed from soluble (reversible) proteins: as a result of the resolution of opacities in the centre of the lens visual acuity may often improve by several points.

New drugs have been proposed for the treatment of cataracts in recent years. Fradkin and his colleagues have pioneered the use of cysteine in the USSR. At present we employ drops containing potassium iodide, calcium chloride, magnesium chloride, cysteine in a relatively large amount, glutamic acid, thiamine, glycine (glycocoll), nicotinic acid, and adenosine.

Cysteine is contraindicated for saucer-shaped cataracts because it facilitates progression of the opacities. It has

to be used constantly, in other types of the disease, with checking of intraocular pressure.

Our own experience confirms the beneficial therapeutic effect of cysteine and a complex preparation viceine; the results achieved with this preparation in many patients exceed those given by other drugs. Riboflavin can be added to the preparation.

It would seem that electrophoresis possesses no particular advantage (as regards therapeutic effect) over instillation into the conjunctival sac. The former method can be used only in a medical institution, which is often inconvenient for the patient, but he may be treated at home by instillation.

Oxygen which is so needed by the lens tissues, and potential and apparent deficiency of which must be made up, can be supplied directly to the eye by one of two methods.

The first method consists in blowing a thin, weak stream of oxygen over the eye (with the eyelids open) directly from an oxygen bag. We prescribe this procedure one to three times daily for three to five minutes. Strictly speaking, a permanent course of treatment is needed as the effect produced by the oxygen is of short duration and hypoxia most probably reappears when the gas is discontinued. For this reason, courses of treatment lasting not less than one month are prescribed periodically after short intervals of rest. This method is quite expedient. The cornea, and in particular its epithelium, allows the passage of oxygen in both directions. Under normal conditions the gas is derived from the air and from tears, and its absorption is obviously less intense than under the pressure of a stream, when pure oxygen is supplied to the cornea.

This treatment can be carried out at home by a member of the patient's family, who has been instructed in the method. We have described its simple technique because, to our knowledge, it has not yet been reported. The procedure was recommended by Pavlova-Kaminskaya who, seemingly, was the first to employ it.

The second method, that of subconjunctival introduction of oxygen (a total of 20 or 30 injections made every two or three days), is well known, and there is no need to describe it here.

CHAPTER 6

SURGICAL TREATMENT

Any injury, whether sustained accidentally or inflicted by a surgeon's hand, whether small or extensive and severe, involves not only the injured organ, but also, to a certain extent, other organs and even the body as a whole. A wound is not a local lesion; it produces a reaction in the entire body. An operation for a cataract must be regarded as both a local and a general trauma (mainly psychic). Therefore surgical management should include such prophylactic and therapeutic measures as will help the body to overcome the trauma, and will mobilize all bodily defence forces.

The term "surgical treatment" or "surgical intervention" embraces three main stages which are inter-connected and are united by a common principle of action, i.e. maximum care with regard to the tissues directly involved and to the body as a whole, and implementation of a complex of measures, both prophylactic and therapeutic to create favourable conditions for the region operated on and for the whole body. The stages are: (1) preoperative management, (2) the operation itself, and (3) postoperative management.

It seems to us necessary to preface the presentation of this subject with a brief sketch of the development of the surgical management of cataract since it reflects the development of medicine in general and of ophthalmology in particular.

Ophthalmology and ophthalmic surgery have existed as a practical discipline since 2,500 B. C. in Egypt. It is possible that some types of operation on the lens were already made in ancient Egypt and Assyria; but there is documentary evidence (the works by Celsus, Pliny, and others written in the first century) that our forebears per-

formed discissions and had made genuine attempts to extract cataract surgically. Paulus Aegineta (seventh century) describes an operation of cataract expression. Later it was proposed to remove cataract by suction through a hollow tube, while the famous Avicenna (ibn-Sina, in the eleventh century) mentions cataract extraction but disapproves of the procedure. Later, a freezing of scientific ideas occurred under the influence of scholasticism and the obscurantism of church dogma in Europe, progressive minds were afraid to be denounced as heretics, and naked practicism prevailed; the physicians of the time were mere artisans. Expression of cataract was the only surgical method used. Even Bartisch mentions only expression of a cataractous lens in his classical work "Ophthalmodouleia" (the end of the sixteenth century). Through the efforts of progressive minds, however, science asserted itself, the ice was broken, and the need to perform cataract extraction was loudly voiced. This paved the way for Daviel who was famed for his planned and systematically performed extractions; he proposed an original method considered progressive at the time, but now archaic. There is no reason to dwell on it here. Suffice it to say that he performed his first operation of this type in 1745 (in 1747, according to some). The well-known ophthalmic historian Hirschberg wrote that Daviel's operation, his only child, proved a lion cub. Over two centuries have passed; the main principle of the operation, the extraction of the cataract, remained, though its technique changed with time. New moments were introduced, it was perfected, and, parádoxically, the simple procedure became more and more complex, the instruments were changed, new ones both simple and complex being invented. Thus, beginning with Daviel's initial operation and passing through the experience of extracapsular extraction, ophthalmic surgery has come to the method of intracapsular extraction by means of a loop, forceps, erysiphake, and cryoextractor, the latest instrument.

In this chapter we shall deal with the modern methods of extraction used by ophthalmic surgeons.

PREOPERATIVE MANAGEMENT

PRELIMINARY PREPARATION OF THE PATIENT

Most of the measures (general ones in the main) used during the three stages of surgical treatment are identical. For that reason it is desirable to begin with a description of those general measures that are aimed at increasing bodily resistance to the complex of harmful factors inevitable in any surgical intervention, and removing and rendering harmless apparent and dormant noxious agents present in the body and in the environment.

In this connection, we would remind readers of the potential endogenic danger of allergies which provide a background for unexpected and undesirable, and sometimes even dangerous, reactions giving rise to various complications under the stimulus of trauma or other accidental factors (foods, drugs, odours, etc.).

We would also like here to add some further points about tranquillizers and sedatives.

One of the most powerful tranquillizers as such is the use of words, the second signalling system. Soothing words, correctly chosen and spoken when needed, and giving the patient hope of good operative results, an easy postoperative period, etc., are probably no less important than the large number of various tranquillizing drugs and preparations. An unfortunate remark, it should be remembered, however, a sceptical glance or gesture made by the physician or any one of the attendant medical staff can cause so severe an iatrogenic condition that all the tranquillizers available will be powerless.

A restful atmosphere should be created for the patient, to prevent the occurrence of disturbing emotions. He should be told what he must do during and after the operation, and given an explanation, in comprehensible terms, of how he will be prepared for the operation, what will be done during the operation, and what results may be expected. The last explanation must be given with great caution and discretion because the "promissory note" must be honoured. It is better to promise less and give more, than vice versa.

While preparing patients psychologically, one must bear

in mind that many of them will have read about cataract but not all will have understood correctly what they read.

Many clinics have made routine use of sleep therapy in the recent years which is a condition of diffuse inhibition involving the cortex and spreading to the subcortical layers. Protective inhibition, however, should only be produced in those patients in whom it occurs as a natural response to a pathological condition. The problem has been widely discussed in the Soviet literature, in works on ophthalmology in particular (Kornblum, 1950; Pavlov and Vladimirova, 1952; Skvorchevskaya, 1952, and others) and there is no need to dwell on it in detail. We shall only remark that sleep therapy is a new and at the same time an old method. It is of interest to note that its beneficial effect attracted the attention of the founders of Russian ophthalmology. Adamyuk (1885) wrote in his classical work: "The latter (prolonged sleep—*M. R.*) is very wholesome here for more opportune healing of the wound and because of this one should advise the patient to sleep after the operation".

Some further points should be added to what has already been said about vitamins, above all about vitamin K, which is a haemostatic and antihaemorrhagic factor stimulating the healing of wounds. We have been using it since 1942 as a preventive measure which makes possible an almost bloodless operation (Rabinovich, 1948). It exerts a particularly pronounced antihaemorrhagic effect upon the small vessels and capillaries that can be a source of heamorrhage during cataract extraction.

Mention should also be made of vitamin P and rutin (melin) which reduce the fragility and permeability of the capillary wall, and of vitamin E whose valuable anticoagulative effect should not be forgotten in appropriate cases (Rabinovich and Badzyma).

Pyrotherapy, applied in the popular form of lactotherapy, or in other ways is an extremely valuable therapeutic method injustifiably neglected today. The activation of adreno-pituitary function in response to this treatment is a strong argument in its favour.

Osmotherapy is another form of treatment to be employed in the pre- and postoperative periods (if the indications are present, naturally). It consists in intravenous in-

jections of hypertonic solutions (40 per cent urotropin [methenamine] solution, 40 per cent glucose solution, 10 per cent sodium chloride solution, 10 per cent sodium iodide solution, etc.). Peroral administration of drugs exerting an osmotic effect has now been accepted in practice, namely a 50 per cent solution of glycerin in lemonade given in a dose of 1.0 or 1.5 grammes per kilogram of body weight, urea, etc. The therapeutic effect of osmotherapy is well-known and there is no need to go into detail of its use. The same applies to tissue therapy and blood transfusion.

Sulphonamides and antibiotics are widely used, since any operation may be complicated by an exogenic infection or by an exacerbation of an endogenic infection already present in a latent state. They are prescribed in the first postoperative days, for prophylactic purposes before the operation and whenever infection occurs. The method of administration is well-known.

The drugs mentioned above have a universal action of very wide range; some cases, however, call for the use of agents with a more specific action: drugs that lower blood pressure in hypertension; endocrine preparations for dysfunction of the endocrine glands, etc.

In order to prescribe the treatment needed, a detailed physical examination of the patient should be made before the operation by a physician, neuropathologist, otorhinolaryngologist, a gynaecologist (for women), and, when necessary, by a dentist (all bad teeth should be treated) and other specialists. Examination of blood and urine (blood count, coagulation time, clot retraction time, bleeding time, prothrombin time, blood type, etc.), should be made, chest X-ray taken, and other forms of examination used. A patient may be put on the operating table only after thorough preparation for surgery.

Parallel with physical examination of the patient and elimination of factors that might disturb the normal course of the operation and the postoperative period, the eye and its accessory structures must be studied and prepared for the operation. This includes morphological and functional studies of all segments of the eye, with particular attention to those factors whose disregard may prove fatal to the results of the operation and even to the eye itself.

The width of the palpebral fissure, the position of the eyeball in the orbit, and the condition of the conjunctiva of the eyelid, particularly at the margins, should be ascertained. Ingrowing eyelashes, entropion, and ectropion should be repaired by surgery. Adequate measures should be applied to control blepharitis and conjunctivitis (especially meibomian).

The cornea should be studied to determine its transparency: slight opacities encountered during operation may be mistaken for cortical remains, and unwary operator may indulge in the dangerous procedure of extracting these false "masses" from the eye.

Any accidental erosions on the cornea can be detected by biomicroscopy or by introducing a 2 per cent solution of fluorescein into the conjunctival sac: irrigation of the sac removes the dye, while those regions of the corneal surface on which desquamation of the epithelium has occurred will take on a yellow-green colour. Biomicroscopy will also detect signs of endothelial dystrophy in the cornea; after an operation even rudimentary signs may transform to degenerating dystrophy, terminating in complete blindness. The posterior corneal surface should also be examined: the presence of fresh deposits points to an active uveal process, surgery should then be delayed. Operation should also be postponed if even a minimum oedema of the cornea is encountered, because it signalizes the presence of a pathological condition (glaucoma, etc.).

The ophthalmic surgeon should also inspect the anterior chamber; its humour must have no flare and contain no cells. The depth of the anterior chamber should be determined, if only approximately, to ascertain whether it is deep or shallow, as this knowledge is important for making a correct incision.

Particular attention must be paid to the condition of the iris, and pupil and their reactions, since choice of operative method and technique depends on them. The presence of anterior or posterior synechiae, for instance, requires special measures: with a brisk reaction of the pupil the possibility of performing the operation with a round pupil should be considered, etc. Iridodonesis is indicative

of lenticular subluxation or ectopy, or of liquefaction of the vitreous.

The lens capsule should be thoroughly examined; the presence of vacuoles indicates sites of structural weakness. These findings will suggest what instruments and what procedure to use (with a strong intact capsule, for example, intracapsular extraction has more chances of success).

The state of the vitreous is also important. Where a fluid vitreous is suspected (complicated cataract, displacement of the lens, etc.), particular attention and special precautions are required during the operation.

The principal aim of local preparation is to protect the eye from exogenic infection (the general preparation of the patient providing for prevention of endogenic infection). A bacterioscopic (smear) and bacteriological (culture) examination of the contents of the conjunctival sac, the primary potential source of infection, should be made, and then the conjunctiva treated thoroughly with drugs (antibiotics, sulphonamides, etc.) until the best possible sterility of the conjunctival sac is produced.

Though doing justice to bacteriological examination, we rely more on the findings yielded by smears, than on the results of cultures prepared two or three days before the operation, since infection can invade the sac during this time.

We recommend the following tactics. A culture is prepared from the sac contents some days before the date of the operation proposed. If it proves sterile, a second culture is made two or three days before the operation; if the results of this control culture are also favourable, the time of operation is set for one of the following days; a final control smear is taken several hours before the operation; even the sterility of this smear does not guarantee absolute sterility of the sac contents. Should pathogenic organisms not found in the culture be detected in the smear it is best to delay the operation and administer a thorough complex treatment according to the principles already described. The presence of pathogenic organisms in any of the cultures is an unconditional indication for postponement of the operation until a relative sterility of the conjunctival sac, the best attainable, is produced.

The lacrymal drainage system is another source of infection. The methods of investigating it and managing pathologic conditions are sufficiently known not to need repeating here. We shall therefore confine ourselves to saying that the ophthalmologist's conscience can only be clear when the lacrymal ducts of a patient lying on the operating table are in a faultless condition.

Examination of intraocular pressure and normalization of any pathological deviations play an important part in preoperative management of a patient. The state should be ascertained with maximum accuracy by tonometric examination of pressure because it indicates what measures should be employed before the operation, while the results of these measures, in turn, dictate certain details of the operative technique. It should be noted that deviations of pressure above or below normal values do not as such contraindicate surgery; an operation may be performed after the intraocular pressure had been normalized by the appropriate treatment.

Immediate Preparation of the Patient

After preliminary preparation has been completed and it has been established that the patient is ready for the operation and that there is no need for delay, immediate preoperative measures are begun. The day before the operation the patient takes a bath, and is given a saline purgative and a soporific.

To ensure a restful and prolonged sleep, and calm behaviour before, during, and after the operation certain measures are undertaken that lessen perception of pain by the brain cortex, reduce excitability, and make the patient drowsy.

Employing the principle of potentiation, tranquillizers (aminazine [chlorpromazine] and propazine) are combined with antihistamines (dimedrol [diphenhydramine], etc.) and analgetics (promedole, etc.). Many schemes have been proposed to potentiate the effect of the tranquillizer; we shall mention only those used in Moscow clinics. A mixture consisting of two millilitres of a 2.5 per cent aminazine solution, two millilitres of a 2 per cent promedole solution, and two millilitres of a 2 per cent dimedrol solution is injected intramus-

cularly one or two hours before the operation, and has been found to have a good effect. Another combination is administered as follows: beginning on the second or third preoperative day, the patient is given bromides, dimedrol (diphenhydramine) (0.03-0.05 gramme two or three times a day), and chlorpromazine (0.025 gramme once or twice a day); on the day before the operation he is given luminal (phenobarbital) or nembutal (pentobarbital sodium) (0.1 gramme).

An hour before the operation a soporific is administered and the patient is given an intramuscular injection of a lytic mixture of 0.025-0.03 gramme of chlorpromazine, 0.02 gramme of diphenhydramine, and 0.01 gramme of promedole.

Under the influence of these combinations of tranquillizers (others may also be used, of course, suggested by the ophthalmologist's experience and the patient's condition), the patient becomes calm and drowsy, and displays a languid response to external stimuli, respiration becomes decelerated and deeper, and blood and intraocular pressure decrease.

This anaesthesia is safe and extremely effective. According to Janert (1957), the expected result is not obtained in only 5 per cent of cases.

The proper use of tranquillizers in combination with adequate administration of anaesthetics enables us to operate on most patients without employing general anaesthesia. The latter is necessary only with small children and very nervous and uncooperative adults in whom a combination of drugs has not produced the required effect.

Even an immaculately performed operation may fail because of an uncooperative patient who disobeys the surgeon's instructions, cannot fix his gaze in the needed direction, squeezes his eyelids, etc. Bearing this in mind, it is advisable to "train" the patient before the operation to look downward, upward, and sideways.

Long and thick eyebrows have to be cut. Many surgeons (we belong to this group) trim the eyelashes as well so that they will not rub against the eye in case of entropion.

On the morning of the operation the patient's bowels are cleansed with an enema, and several drops of opium are administered to inhibit gastrointestinal function, and at the same time the opium acts as an analgesic. The patient then drinks a

cup of weak tea, eats a light breakfast, and is left to doze until taken to the operating theatre where the final preoperative procedures are made.

Before the general use of antibiotics, we employed a 0.5-1 per cent solution of silver nitrate for a number of years, installing one drop into the conjunctival sac 45 or 60 minutes before the operation. This solution coagulates the surface conjunctival layers, forming a film in which microorganisms are washed out of the sac while the patient is on the operating table. The procedure can still be employed today.

Preliminary instillation anaesthesia with 0.5-1 per cent dicaine (tetracaine) is administered in the preoperating room. A minimum of time should be spent in this room, where it is advisable to engage the patient in soothing, reassuring talk. Then he is led into the operating room, placed on the operating table, and covered with sterile drapes (sheet, towel, etc.). The conjunctival sac is abundantly irrigated with an antiseptic solution: rivanol (1:1,000), furacilin (1:5,000), a solution of penicillin, or some other antibiotic, or a mercuric oxycyanide solution. The last two agents should be used with great caution as they can cause a severe local reaction due to allergy, forcing the operation to be postponed for a lengthy period. Ointments are not recommended for the same reason; moreover, traces of ointment may remain in the sac and be a hindrance during the operation.

The operative field is prepared when the patient is on the operating table. The scrub nurse or the assistant surgeon washes the region of the orbit (the eyelids and the surrounding skin on the forehead, cheeks, and nose) thoroughly with soap and water but not rubbing very hard, then rinses off the soap with one of the solutions mentioned above or with a physiological saline solution, boric acid solution, sodium carbonate solution, etc., and once more irrigates the sac, having first everted the eyelids. The skin is then dried and painted either with a mixture of half tincture iodine half glycerin, or with a 1 per cent alcoholic solution of brilliant green. The margins of the lids and roots of the eyelashes are painted separately. On completion of this procedure, the patient's face is covered with a sterile linen cloth, or two-three layers of sterile gauze, with openings for the operative field.

The patient keeps his eyes closed until the operation begins, sterile gauze being placed over them.

With this, preparation of the patient for operation is completed.

PREPARATION OF THE OPERATING THEATRE AND OPERATING PERSONNEL

The creation of sterility in the operating theatre is the inimmutable and general rule of surgery. We shall not dwell on this but would single out several points.

Many methods have been proposed for the preparation and treatment of the hands of the operating team. We use the following procedures (in the order in which they are described): the hands and forearms are washed for two or three minutes with soap and running hot water, using a scrubbing brush; the hands are immersed for five minutes in a 0.25 per cent ammonium hydroxide solution in hot water; the procedure is repeated in a fresh solution; the wet hands are treated with 96° alcohol or dried hands are treated with 70° alcohol; a sterile operating gown is put on; the hands are again rubbed with alcohol; the fingers are painted with a 5 per cent tincture of iodine or with a half-and-half mixture of 10 per cent tincture of iodine and glycerin.

Experience has shown that this method guarantees an adequate condition of the operator's hands.

Many surgeons operate wearing gloves. Filatov, who always used gloves, treated them with brilliant green. There is nothing against this, but we have rejected the method because we consider gloves unnecessary, and they are undoubtedly inconvenient when conducting such delicate operations as extraction of a cataract.

A very clear visualization of the operative field in all its details is indispensable for cataract extraction. It may be created by adequate illumination and a certain degree of magnification: the former is provided by a shadowless ceiling lamp and a hand lamp, and the latter by a binocular loupe worn on the forehead. With a well organized theatre and coordinated work of the personnel, the operating team can be limited to the surgeon, an experienced scrub nurse, and one

assistant, though, strictly speaking, the operation can be done without the help of an assistant: the fewer the number of hands involved in the operation, the smaller is the danger of infection. One should not forget the old adage that infection is harboured at the finger-ends. Extraction of the cataract is performed with the instruments commonly employed and a device for oxygen insufflation. We consider it necessary, however, to stress the need for good quality instruments —a sharp knife and cystotome, adequate fixation forceps, and a faultlessly operating erysiphake and cryoextractor.

OPERATION

A description of the methods and technique of cataract extraction requires prefacing with several observations of a general character.

The past twenty or thirty years have contributed a number of advances in the surgical management of cataract. Among them is the introduction of means that make the operation relatively harmless; this refers in particular to intracapsular extraction, an operation that allows immature cataracts to be removed. As well, close attention is now paid to the grave dangers associated with non-refilling of the anterior chamber and postoperative collapse of the cornea and with the condition that occurs when the vitreous comes in contact with the corneal endothelium, the harmful effect of which cannot be overestimated.

We would like to give some advice and suggest certain rules to be observed whatever operative method is used.

1. The patient should be adequately prepared for the operation according to the procedure outlined above.

2. No pressure, however slight, should be exerted on the eyeball during the operation; such pressure may be caused by excessive infiltration of the lids during acinesia, retrobulbar haemorrhage due to a carelessly- and inadequately-made retrobulbar injection, incomplete acinesia of the lids, excessive pull on the bridle suture, accidental pressure exerted on the sclera or cornea by an instrument, cotton rolls, etc. To avoid pressure, we advise that a speculum or a blepharostat should never be used after the eyeball has been opened.

3. A canthotomy is indicated if the eye lies deep in the orbit and if the acinesia or anaesthesia is inadequate.

Whatever the method of operation, it always comprises a number of procedures which will be described in the order in which they are performed. Some of them are obligatory, while others are optional (e.g. iridotomy, or iridectomy, etc.).

Dilation of the pupil and anaesthesia. The operation should be performed on an adequately anaesthetized eye with maximum dilation of the pupil. Instillation anaesthesia is produced with a 1 per cent tetracaine solution instilled one or two drops at a time into the conjunctival sac two or three times at five-minute intervals; the procedure may be started while the patient is still in the anteroom of the theatre. Deeper anaesthesia, and maximum dilation of the pupil for each patient can be produced by placing a small cotton roll, soaked in a half-and-half mixture of 3 per cent cocaine and 1:1,000 adrenalin, under the lower lid 20 or 25 minutes before the operation. In the absence of firm adhesions between the pupillary edge and the lens capsule (complicated cataract) maximum dilation of the pupil occurs; what is more important, the pupil does not contract after the anterior chamber is opened, as it does when atropine is used (Rabinovich, 1933). A valuable property of adrenalin is its ability to cause a decrease in intraocular pressure, which is now widely utilized in simple glaucoma.

If the procedure here described proves ineffective, it can be supplemented with a subconjunctival injection of 0.1 millilitre of adrenalin solution, if the patient's physical condition allows it, of course. When still deeper anaesthesia is required (with agitated, nervous, and sensitive patients, who respond badly to any, even painless, manipulation), a retrobulbar injection is made of one or two millilitres of a 2 per cent novocain solution and 0.1 millilitre of adrenalin (unless the latter has been previously introduced to dilate the pupil).

Retrobulbar anaesthesia technique. The skin at the lower external angle of the orbit is pressed to the underlying bone with the left index finger. A 3.0 or 3.5 centimetre needle is inserted at this site with a quick movement and moved upward and medially to the apex of the

orbit, while pressure is exerted on the plunger of the syringe. In this way the solution is injected gradually, the needle being slightly rocked so that the novocain spreads to all sides, forms a muff around the ciliary ganglion and blocks it. Injection through the conjunctiva has no advantages over this method.

The anaesthesia described above is valuable because the solution introduced behind the eyeball pushes it slightly forward, which greatly facilitates manipulations on a deeply set eye, and in cases of a high bridge of the nose. The solution thus injected also decreases intraocular pressure, and this can also sometimes be utilized. It should, however, be borne in mind that hypotonia of the eye may occur, which will complicate further procedures. For that reason, the operation should begin as soon as retrobulbar anaesthesia has been administered so that all manipulations will be completed for the most part before marked hypotonia occurs, i.e. within five or six minutes.

A better, quicker, and deeper effect will be produced if a small amount of hyaluronidase (one or two ampules of dry hyaluronidase, i.e. one or two milligrams, or 100-200 turbidity units) is added to the novocain solution.

Acinesia of the eyelids. The natural, commonly-occurring opening of the palpebral fissure does not provide the conditions necessary for the operation, so it must be done artificially. The technique must meet the following requirements: the opening caused should be maximum and stable; the procedure should not disturb sterility; it should be simple and harmless, and should allow the lids to be closed instantly but not abruptly or convulsively otherwise iris prolapse, vitreous loss, or other complications may occur. The technique combining acinesia with a bridle suture placed on the superior rectus muscle satisfies these requirements.

Adequate acinesia is indispensable for the operation to be performed calmly and without hazards. The value of this though simple but effective manipulation is obvious and commonly acknowledged, and needs no advocating. Acinesia is obtained by an injection of four to six millilitres of a 2 per cent novocain solution (several drops of 1:1,000 adrenalin solution are added if blood pressure is normal).

For a more rapid absorption of the solution, the amount of hyaluronidase mentioned above should be added and slight pressure be exerted over the temple for two or three minutes following the injection. Acinesia allows us to avoid use of a speculum or blepharostat, these instruments not only being inconvenient but also dangerous under certain conditions.

Many methods of obtaining acinesia have been described. That proposed by van Lint in 1914 is the oldest, and we consider it one of the best, if not the best, because of its simplicity and efficacy, and have always use it, with certain modifications.

Technique. The needle is inserted at the intersection of a horizontal line passing 0.5 centimetre below the inferior orbital margin, and a vertical line passing 0.5 centimetre peripheral to the lateral orbital margin. After 0.2 millilitre of the solution has been injected here, the needle is pulled slightly and then directed to the nose and advanced horizontally along the entire inferior orbital margin; then 1.5 to 2.0 millilitres of the solution is introduced and the needle is withdrawn almost to the point of insertion and then directed upward and about one millilitre is injected in this direction. After that, the needle is advanced along the superior orbital margin, and the solution is gradually introduced in the immediate vicinity of the margin. Acinesia is produced within six or eight minutes.

A bridle suture is placed on the superior rectus muscle to fix the eyeball.

Technique (Fig. 12). The patient is told to look down "at his feet". If he cannot do this, the conjunctiva is grasped with a fixation forceps at 6 o'clock, as described later, and the eye turned in the direction needed; as a result the eye surface lying above the cornea becomes accessible for manipulations. The slightly parted blades of eye forceps are placed vertically on the eyeball above the site where the superior rectus muscle is in contiguity with the tendon and are then closed, while slight pressure is exerted on the eye; in this way the muscle is grasped. The less the conjunctiva is grasped, the better. With the muscle raised, a surgical needle with a long strong silk thread is passed under the muscle. This should be done delicately without damaging the tissues, and without causing a haemorrhage since the oc-

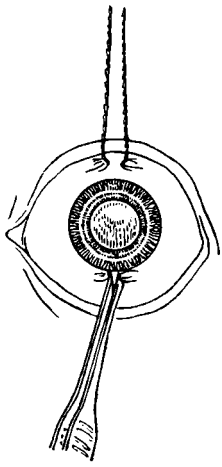


Fig. 12 Fixation of the eyeball by means of a bridle suture and fixation forceps

currence of a haematoma is very undesirable here.

By pulling on the suture, the eyeball is turned downwards and fixed in that position. Thus movement around the vertical axis is arrested, but movements around the horizontal axis are still possible. For that reason, further measures must be applied so that the eyeball is completely immovable. This is achieved by means of a fixation forceps supplied with three fine teeth. The forceps should be placed across the limbus (at 6 o'clock), grasping the conjunctiva where it is attached to the limbus and where it is in contiguity with the surface corneal layers. If the conjunctiva alone is grasped, the eyeball will retain a certain mobility, since only the conjunctiva covering it and not the eye itself will be fixed. In an effort to immobilize the eye the surgeon then involuntarily puts pressure upon it with the forceps, which is absolutely impermissible. On the contrary, the forceps should be raised slightly, and the eyeball held suspended, creating a certain negative intraocular pressure. A mild proptosis of the eye occurs as a result, making it more accessible. The forceps holds the lower lid at the same time; the latter may also be retracted with a blunt hook. It should be remembered that the eyeball must be fixed at two points: with a bridle suture at the site of attachment of the superior rectus muscle to the sclera (first point), and at the 6 o'clock meridian on the limbus (second point).

Many surgeons reinforce immobilization by injecting 0.5 millilitre of a 2 per cent novocain solution into the superior rectus muscle. There is no objection to this additional procedure but with adequate acinesia, a proper suture, and grasping of the conjunctiva at 6 o'clock, it is not necessary. While on the question of bridle sutures, yet another of their advantages should be mentioned. The suture is drawn

over and across the upper lid and thus holds it in place; as a result there is no need to place additional sutures on the lid, and thus no additional trauma associated with that procedure is inflicted.

The method and technique of the further stages of the operation vary according to the type of the cataract; we shall describe these stages as they are carried out for each type, beginning with a description of the operation used for senile cataract since this is the prevalent type responsible for 95 per cent of the incidence of cataract.

OPERATIONS FOR SIMPLE CATARACTS

A. Senile Cataract

The aim of the surgeon performing an operation for cataract is to remove the lens from the eyeball leaving if possible no remains. The trauma inevitably inflicted during the operative procedure should be the minimum. Lenticular remains require another operation and contribute to the occurrence of complications both during the operation and after it.

Modern methods of extraction of a senile cataract comprise two types of technique which differ in principle: (a) intracapsular extraction, and (b) extracapsular extraction. Since the differences between the two techniques are significant, we shall describe them separately. We shall not, however, attempt to outline all the numerous methods employed but will dwell only on those that we have used after the inevitable modifications and improvements prompted by experience. We shall also deal briefly with certain rational variations of the technique adopted by us. The first to be described is intracapsular extraction since it is the more modern and rational method.

INTRACAPSULAR EXTRACTION

Placement of the Corneal Sutures. Formation of the Conjunctival Flap

The next stage of the operation may be regarded as a prophylactic measure to ensure smooth healing of the (future) incision. It comprises the application of sutures to its edges or the formation of a conjunctival flap for its closure.

It is unlikely that any surgeon today will dispute the value of, or to be more precise, the need for measures to make the incision airtight, whether by applying sutures or a flap. Closure of the incision, however, has other virtues besides protection of the eye from exogenic infection.

The value of the procedure is illustrated by Rouher's comparative data cited by Coscas and Halimi (1966). Inverse astigmatism occurred in 80 per cent of eyes operated on without sutures, and direct astigmatism in 12 per cent; only in 3 per cent did no astigmatism develop. The respective figures where sutures were applied were 52, 31, and 12 per cent; they are a convincing argument in favour of closure of the incision.

Both the sutures and the flap have their advocates and their opponents. Those who support the sutures point to the fact that less trauma is inflicted on the eye, that there is less or no bleeding, and that the apposition of the wound edges is even better than when the incision is covered with a flap. Advocates of the flap hold that it minimizes the number of cases of epithelial invasion of the anterior chamber.

Acknowledging the valuable points of both methods and recognizing their shortcomings, we recommend the tactics that we have used: we prefer sutures as a rule, but employ the flap when there is no full assurance that either the conjunctival sac or the lacrymal drainage system is adequately clean.

The sutures may be placed either before the section is made or after. The later method is opposed on the grounds that performance of this manipulation on an exposed eye is far from safe; in addition, it is often impossible, as is in the case of vitreous loss when an attempt to place sutures as a rule causes further loss and leads to fatal after-effects.

The placing of sutures before the section, on the contrary, is quite feasible. Time and experience have shown that the suture proposed (Rabinovich, 1933), and constantly used by us, guarantees complete safety of the further manipulations.

Many similar sutures have been proposed by different surgeons. Although catgut has certain advantages over silk (being absorbable and not having to be removed), we use silk sutures because catgut is resilient, bristles when being tied, and excites irritation in the tissues.

Corneo-episclero-conjunctival suture placed after our method. A long thread of silk (size 00 or 000) armed with two corneal needles (Fig. 13) is passed through the thick of the cornea

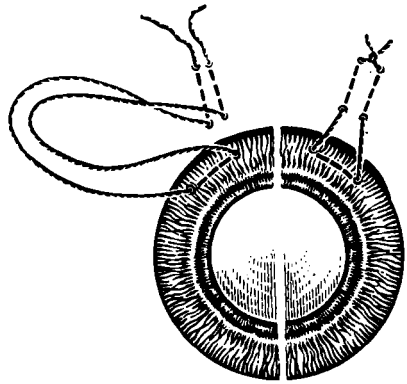


Fig. 13 Corneo-episclero-conjunctival sutures proposed by the author

in a horizontal direction parallel to and at a distance of 1.0 or 1.5 millimetres from the superior limbus: the middle part of this suture lies at 11 o'clock. A suture placed superficially cuts through, while one placed too deep may perforate the cornea and enter the anterior chamber which is not only undesirable but is very dangerous (infection, endothelial dystrophy, etc.). The "groove" in the cornea is about 2.0 or 2.5 millimetres in length. Then the needles are inserted one after the other through the episclera at a distance of about 1.5 millimetres from the limbus, and both ends of the

thread are drawn perpendicular to it, the needles making their exit 2.5 to 3.0 millimetres from the limbus.

A second suture is placed in a similar manner at one o'clock. Then wide loops are made and are drawn aside and covered with a moistened gauze tampon; in this way they do not interfere with further manipulations, the earliest of which is a section made on the eyeball. After the section (the technique is described later), the assistant pulls on the ends of both threads lying across it, but not so hard as to allow its edges to part and let the lens through.

These two sutures ensure tight closure of the incision and exclude or minimize the possibility of iris prolapse or vitreous loss through it. The smaller the number of sutures, the better, since they delay healing and can cause tissue necrosis. The sutures proposed here have the following advantages: (1) they are placed prior to the section; (2) by pulling on, or loosening the hold of the threads lying across the section, one can control the opening of the wound (i.e. adapt it so as to let the intact lens or remnants through, to prevent iris prolapse and vitreous loss, to allow oxygen insufflation, etc.); (3) without lessening the needed tension on the threads, they can be tied easily and safely after the operation has been completed.

When the sutures are finally tied, the eye conjunctiva forms a double fold, a peculiar flap slightly covering the incision. This flap is advantageous because, covering the wound with its epithelial surface, it does not adhere to it but easily unfolds and retracts after the sutures have been removed.

The sutures are removed not earlier than on the seventh or eighth postoperative day; this is done with particular care so as not to perforate the anterior chamber by a careless movement. We perform this simple but crucial procedure without grasping the suture with a forceps; we cut under the knot with fine scissors and then remove the suture whole.

The construction of a conjuctival flap for closure the wound has many supporters; they probably outnumber the supporters of sutures. We shall describe only the method

that in our opinion best satisfies the following requirements: the flap is created (formation of flap and placement of sutures) prior to the section, and completely covers the wound. This method, a modification of ones used earlier, was proposed by Arkhangelsky (1943). A curved incision concentric with the limbus is started slightly below the insertion of the superior rectus muscle and prolonged along both sides to the horizontal meridian; the flap is dissected and three sutures are placed on its edges: one at 12 o'clock and two corresponding to the ends of the incision. Only then is the eye section performed. The conjunctival sutures are tied at the end of the operation.

A third method to cover the wound exists—a combination of a corneoscleral suture with a conjunctival flap. This form of corneo-episclero-conjunctival suture was suggested by Zolotareva. A conjunctival flap is formed as described above, two horizontal conjunctival incisions are made from its edges to the limbus, and then a mattress corneo-episcleral-conjunctival suture is applied. Following extraction of the lens, the flap is stitched to the conjunctiva with four or five sutures and the corneal suture is tied.

Gnetova (1961) presents interesting comparative data on the advantages and shortcomings of operations performed with a flap and without.

In 210 operations made with a flap, the wound edges separated in 4 per cent of the cases, while in 170 operations employing sutures, the edges separated in 1.2 per cent of the cases, iritis occurred in 7 per cent and 2.8 per cent of the cases respectively, choroidal detachment in 5 per cent and 3.6 per cent, and epithelial invasion of the anterior chamber, in 0 per cent and 2.3 per cent.

We venture to make the following summary of the subject of wound closure: both methods have their advantages and shortcomings. The choice rests with the surgeon and should be made with due consideration of each individual case. We prefer the corneo-episcleral sutures proposed by us; in the presence of indications, we either cover the wound with the epithelial surface of the conjunctiva or construct a large conjunctival flap. That is the approach we recommend.

The placing of sutures before the section, on the contrary, is quite feasible. Time and experience have shown that the suture proposed (Rabinovich, 1933), and constantly used by us, guarantees complete safety of the further manipulations.

Many similar sutures have been proposed by different surgeons. Although catgut has certain advantages over silk (being absorbable and not having to be removed), we use silk sutures because catgut is resilient, bristles when being tied, and excites irritation in the tissues.

Corneo-episclero-conjunctival suture placed after our method. A long thread of silk (size 00 or 000) armed with two corneal needles (Fig. 13) is passed through the thick of the cornea

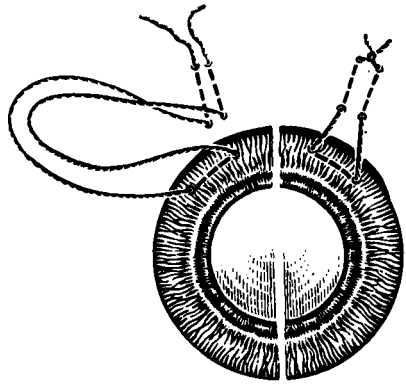


Fig. 13 Corneo-episclero-conjunctival sutures proposed by the author

in a horizontal direction parallel to and at a distance of 1.0 or 1.5 millimetres from the superior limbus: the middle part of this suture lies at 11 o'clock. A suture placed superficially cuts through, while one placed too deep may perforate the cornea and enter the anterior chamber which is not only undesirable but is very dangerous (infection, endothelial dystrophy, etc.). The "groove" in the cornea is about 2.0 or 2.5 millimetres in length. Then the needles are inserted one after the other through the episclera at a distance of about 1.5 millimetres from the limbus, and both ends of the

INTRACAPSULAR EXTRACTION

Placement of the Corneal Sutures. Formation of the Conjunctival Flap

The next stage of the operation may be regarded as a prophylactic measure to ensure smooth healing of the (future) incision. It comprises the application of sutures to its edges or the formation of a conjunctival flap for its closure.

It is unlikely that any surgeon today will dispute the value of, or to be more precise, the need for measures to make the incision airtight, whether by applying sutures or a flap. Closure of the incision, however, has other virtues besides protection of the eye from exogenic infection.

The value of the procedure is illustrated by Rouher's comparative data cited by Coscas and Halimi (1966). Inverse astigmatism occurred in 80 per cent of eyes operated on without sutures, and direct astigmatism in 12 per cent; only in 3 per cent did no astigmatism develop. The respective figures where sutures were applied were 52, 31, and 12 per cent; they are a convincing argument in favour of closure of the incision.

Both the sutures and the flap have their advocates and their opponents. Those who support the sutures point to the fact that less trauma is inflicted on the eye, that there is less or no bleeding, and that the apposition of the wound edges is even better than when the incision is covered with a flap. Advocates of the flap hold that it minimizes the number of cases of epithelial invasion of the anterior chamber.

Acknowledging the valuable points of both methods and recognizing their shortcomings, we recommend the tactics that we have used: we prefer sutures as a rule, but employ the flap when there is no full assurance that either the conjunctival sac or the lacrymal drainage system is adequately clean.

The sutures may be placed either before the section is made or after. The later method is opposed on the grounds that performance of this manipulation on an exposed eye is far from safe; in addition, it is often impossible, as is in the case of vitreous loss when an attempt to place sutures as a rule causes further loss and leads to fatal after-effects.

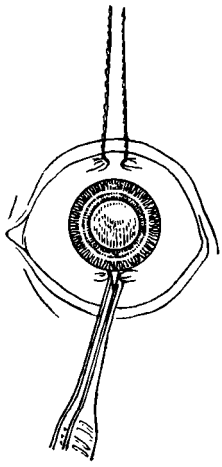


Fig. 12 Fixation of the eyeball by means of a bridle suture and fixation forceps

currence of a haematoma is very undesirable here.

By pulling on the suture, the eyeball is turned downwards and fixed in that position. Thus movement around the vertical axis is arrested, but movements around the horizontal axis are still possible. For that reason, further measures must be applied so that the eyeball is completely immovable. This is achieved by means of a fixation forceps supplied with three fine teeth. The forceps should be placed across the limbus (at 6 o'clock), grasping the conjunctiva where it is attached to the limbus and where it is in contiguity with the surface corneal layers. If the conjunctiva alone is grasped, the eyeball will retain a certain mobility, since only the conjunctiva covering it and not the eye itself will be fixed. In an effort to immobilize the eye the surgeon then involuntarily puts pressure upon it with the forceps, which is absolutely impermissible. On the contrary, the forceps should be raised slightly, and the eyeball held suspended, creating a certain negative intraocular pressure. A mild proptosis of the eye occurs as a result, making it more accessible. The forceps holds the lower lid at the same time; the latter may also be retracted with a blunt hook. It should be remembered that the eyeball must be fixed at two points: with a bridle suture at the site of attachment of the superior rectus muscle to the sclera (first point), and at the 6 o'clock meridian on the limbus (second point).

Many surgeons reinforce immobilization by injecting 0.5 millilitre of a 2 per cent novocain solution into the superior rectus muscle. There is no objection to this additional procedure but with adequate acinesia, a proper suture, and grasping of the conjunctiva at 6 o'clock, it is not necessary. While on the question of bridle sutures, yet another of their advantages should be mentioned. The suture is drawn

over and across the upper lid and thus holds it in place; as a result there is no need to place additional sutures on the lid, and thus no additional trauma associated with that procedure is inflicted.

The method and technique of the further stages of the operation vary according to the type of the cataract; we shall describe these stages as they are carried out for each type, beginning with a description of the operation used for senile cataract since this is the prevalent type responsible for 95 per cent of the incidence of cataract.

OPERATIONS FOR SIMPLE CATARACTS

A. Senile Cataract

The aim of the surgeon performing an operation for cataract is to remove the lens from the eyeball leaving if possible no remains. The trauma inevitably inflicted during the operative procedure should be the minimum. Lenticular remains require another operation and contribute to the occurrence of complications both during the operation and after it.

Modern methods of extraction of a senile cataract comprise two types of technique which differ in principle: (a) intracapsular extraction, and (b) extracapsular extraction. Since the differences between the two techniques are significant, we shall describe them separately. We shall not, however, attempt to outline all the numerous methods employed but will dwell only on those that we have used after the inevitable modifications and improvements prompted by experience. We shall also deal briefly with certain rational variations of the technique adopted by us. The first to be described is intracapsular extraction since it is the more modern and rational method.

INTRACAPSULAR EXTRACTION

Placement of the Corneal Sutures. Formation of the Conjunctival Flap

The next stage of the operation may be regarded as a prophylactic measure to ensure smooth healing of the (future) incision. It comprises the application of sutures to its edges or the formation of a conjunctival flap for its closure.

It is unlikely that any surgeon today will dispute the value of, or to be more precise, the need for measures to make the incision airtight, whether by applying sutures or a flap. Closure of the incision, however, has other virtues besides protection of the eye from exogenic infection.

The value of the procedure is illustrated by Rouher's comparative data cited by Coscas and Halimi (1966). Inverse astigmatism occurred in 80 per cent of eyes operated on without sutures, and direct astigmatism in 12 per cent; only in 3 per cent did no astigmatism develop. The respective figures where sutures were applied were 52, 31, and 12 per cent; they are a convincing argument in favour of closure of the incision.

Both the sutures and the flap have their advocates and their opponents. Those who support the sutures point to the fact that less trauma is inflicted on the eye, that there is less or no bleeding, and that the apposition of the wound edges is even better than when the incision is covered with a flap. Advocates of the flap hold that it minimizes the number of cases of epithelial invasion of the anterior chamber.

Acknowledging the valuable points of both methods and recognizing their shortcomings, we recommend the tactics that we have used: we prefer sutures as a rule, but employ the flap when there is no full assurance that either the conjunctival sac or the lacrymal drainage system is adequately clean.

The sutures may be placed either before the section is made or after. The later method is opposed on the grounds that performance of this manipulation on an exposed eye is far from safe; in addition, it is often impossible, as is in the case of vitreous loss when an attempt to place sutures as a rule causes further loss and leads to fatal after-effects.

The placing of sutures before the section, on the contrary, is quite feasible. Time and experience have shown that the suture proposed (Rabinovich, 1933), and constantly used by us, guarantees complete safety of the further manipulations.

Many similar sutures have been proposed by different surgeons. Although catgut has certain advantages over silk (being absorbable and not having to be removed), we use silk sutures because catgut is resilient, bristles when being tied, and excites irritation in the tissues.

Corneo-episclero-conjunctival suture placed after our method. A long thread of silk (size 00 or 000) armed with two corneal needles (Fig. 13) is passed through the thick of the cornea

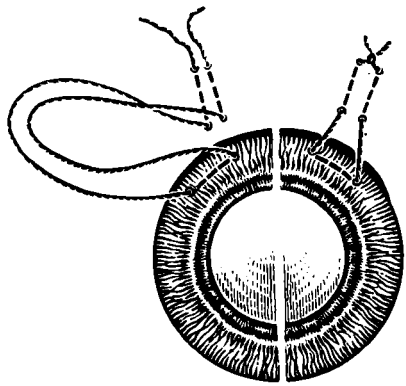


Fig. 13 Corneo-episclero-conjunctival sutures proposed by the author

in a horizontal direction parallel to and at a distance of 1.0 or 1.5 millimetres from the superior limbus: the middle part of this suture lies at 11 o'clock. A suture placed superficially cuts through, while one placed too deep may perforate the cornea and enter the anterior chamber which is not only undesirable but is very dangerous (infection, endothelial dystrophy, etc.). The "groove" in the cornea is about 2.0 or 2.5 millimetres in length. Then the needles are inserted one after the other through the episclera at a distance of about 1.5 millimetres from the limbus, and both ends of the

thread are drawn perpendicular to it, the needles making their exit 2.5 to 3.0 millimetres from the limbus.

A second suture is placed in a similar manner at one o'clock. Then wide loops are made and are drawn aside and covered with a moistened gauze tampon; in this way they do not interfere with further manipulations, the earliest of which is a section made on the eyeball. After the section (the technique is described later), the assistant pulls on the ends of both threads lying across it, but not so hard as to allow its edges to part and let the lens through.

These two sutures ensure tight closure of the incision and exclude or minimize the possibility of iris prolapse or vitreous loss through it. The smaller the number of sutures, the better, since they delay healing and can cause tissue necrosis. The sutures proposed here have the following advantages: (1) they are placed prior to the section; (2) by pulling on, or loosening the hold of the threads lying across the section, one can control the opening of the wound (i.e. adapt it so as to let the intact lens or remnants through, to prevent iris prolapse and vitreous loss, to allow oxygen insufflation, etc.); (3) without lessening the needed tension on the threads, they can be tied easily and safely after the operation has been completed.

When the sutures are finally tied, the eye conjunctiva forms a double fold, a peculiar flap slightly covering the incision. This flap is advantageous because, covering the wound with its epithelial surface, it does not adhere to it but easily unfolds ahd retracts after the sutures have been removed.

The sutures are removed not earlier than on the seventh or eighth postoperative day; this is done with particular care so as not to perforate the anterior chamber by a careless movement. We perform this simple but crucial procedure without grasping the suture with a forceps; we cut under the knot with fine scissors and then remove the suture whole.

The construction of a conjuctival flap for closure the wound has many supporters; they probably outnumber the supporters of sutures. We shall describe only the method

that in our opinion best satisfies the following requirements: the flap is created (formation of flap and placement of sutures) prior to the section, and completely covers the wound. This method, a modification of ones used earlier, was proposed by Arkhangelsky (1943). A curved incision concentric with the limbus is started slightly below the insertion of the superior rectus muscle and prolonged along both sides to the horizontal meridian; the flap is dissected and three sutures are placed on its edges: one at 12 o'clock and two corresponding to the ends of the incision. Only then is the eye section performed. The conjunctival sutures are tied at the end of the operation.

A third method to cover the wound exists—a combination of a corneoscleral suture with a conjunctival flap. This form of corneo-episclero-conjunctival suture was suggested by Zolotareva. A conjunctival flap is formed as described above, two horizontal conjunctival incisions are made from its edges to the limbus, and then a mattress corneo-episcleral-conjunctival suture is applied. Following extraction of the lens, the flap is stitched to the conjunctiva with four or five sutures and the corneal suture is tied.

Gnetova (1961) presents interesting comparative data on the advantages and shortcomings of operations performed with a flap and without.

In 210 operations made with a flap, the wound edges separated in 4 per cent of the cases, while in 170 operations employing sutures, the edges separated in 1.2 per cent of the cases, iritis occurred in 7 per cent and 2.8 per cent of the cases respectively, choroidal detachment in 5 per cent and 3.6 per cent, and epithelial invasion of the anterior chamber, in 0 per cent and 2.3 per cent.

We venture to make the following summary of the subject of wound closure: both methods have their advantages and shortcomings. The choice rests with the surgeon and should be made with due consideration of each individual case. We prefer the corneo-episcleral sutures proposed by us; in the presence of indications, we either cover the wound with the epithelial surface of the conjunctiva or construct a large conjunctival flap. That is the approach we recommend.

Section

To extract a senile cataract the so-called flap-shaped incision is used nowadays. This section is made along the corneoscleral junction in a plane parallel to the corneal base and perpendicular to the axis of the eye. We shall describe the procedure in detail since both the course of the operation and the postoperative results depend on how well it is done.

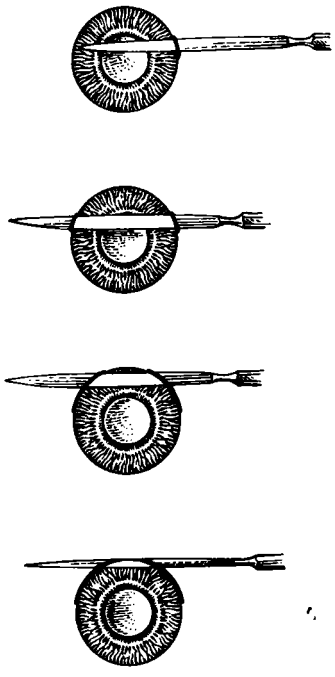


Fig. 14*a* Flap-shaped section made with a linear Graefe knife

We have already mentioned that the incision may be performed with various instruments. Which should be preferred? What method should be used? All methods would appear to be good, but the choice between one instrument or another should be personal. A linear Graefe knife should normally be used (we prefer a slender narrow knife, but this is a matter of choice). Care must be taken not to cut the sutures. With a shallow anterior chamber we first make a short incision (Fig. 14*a*) with a Graefe knife or with a keratome (Fig. 14*b*), and then extend it with scissors (Fig. 14*c*). When a knife is used, the transition of the short incision to the part made by scissors is less abrupt.

The second problem to be considered is which type of section is more suitable—vertical (perpendicular) or bevelled? The edges of a vertical incision can be approximated better, while a bevelled incision serves as a valve which facilitates rapid refilling of the chamber and a firmer closure of the wound. It seems to us that a combined incision is best starting with a vertical incision, and then bevelling it slightly between 11 and 1 o'clock.

Fig. 14*b* Section made with a keratome

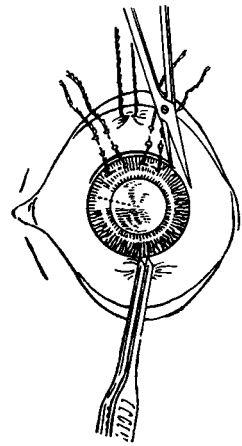


Fig. 14*c* Section made with scissors

The knife is gently held with the thumb and the index and middle fingers, while the ring and little fingers rest on the patient's cheekbone. When operating on the right eye the surgeon stands behind the patient's head, and when operating on the left eye, at his left side (vice versa if the surgeon is left-handed).

The knife is inserted into the limbus one or two millimetres above the horizontal meridian. The length of the incision should be a little more than two-fifths of the limbal circumference; this is large enough to allow intracapsular delivery of the lens. The correctness of this is shown by a simple calculation: the diameter of the cornea is 11 to 12 millimetres, and its radius 5.5 to 6.0 millimetres, therefore the length of the limbus involved in the incision (the length of the circumference $=\pi R$) is approximately 3.5 to 3.75 centimetres, while two-fifths of that length is 1.4 to 1.5 centimetres. The knife should be inserted with a quick but precise movement.

When the tip of the knife appears in the anterior chamber, it is carefully and smoothly moved horizontally across the chamber and a counterpuncture in the limbus is made. It is quite possible to make a mistake during this

last manipulation, which could prove dangerous and even fatal. Due to an optical illusion the tip of the blade may appear to be much deeper than it actually is. It should also be remembered that the limbus lies about two millimetres in front of the anterior chamber angle, so that, if the knife enters the angle during the counterpuncture, it will pierce the eyeball in the sclera far behind the limbus. This is undesirable because veins and plexuses will be injured, the chamber will be filled with blood, and further operative procedures will be made difficult.

In preparing to manipulate with the knife, one should make sure that its sharp edge is turned upward, toward the limbus. An error in this respect, however, is not irretrievable; if it is overlooked, and the knife is inserted in the wrong manner with the sharp edge downward, there is no need to withdraw it and postpone the operation until the restoration of the chamber. In no case do we recommend withdraw the knife and immediately make an attempt to reenter the slit, because this usually involves injury to the iris, and there is no need to explain why that is undesirable. There is a very simple way to correct the error: with a quick movement of the fingers holding the knife, it is rotated 180 degrees around its longitudinal axis without being withdrawn from the wound and its sharp edge is turned upward. Due to the elasticity of the tissues, the thin linear knife can easily be turned in the wound without causing any danger.

Our experience categorically refutes the opinion voiced by older authors that this manipulation is dangerous. Callahan suggests that after filling the anterior chamber with a sterile physiological solution sharp-pointed scissors should be inserted in the puncture wound and the section made with them. If rotation of the knife, however, evokes fear, then it is best to withdraw it from the wound, insufflate the anterior chamber with oxygen for its restoration (as described later), and again introduce the knife into the puncture wound, in the right position of course.

Puncture and counterpuncture having been made, the section is completed with several light, broad sawing motions: the fewer the number of movements, the better. With experience, the section can be made with two or three

movements, the knife being moved upward but without exerting pressure on the tissues being cut (sawn, to be more precise). It is held parallel to the iris during the section; but to complete the procedure its sharp edge is turned forward (upward) (see Fig. 14*a*).

Some surgeons prefer to make the section with a keratome. The technique is as follows (see Fig. 14*b*). The tip of the keratome is placed on the limbus at an angle of 45 degrees at 12 o'clock, and a puncture made by pressing slightly on it; the bevel of the keratome prevents lamination of the cornea. As soon as the tip appears in the anterior chamber, the handle of the instrument is lowered so that the blade plane is directed parallel to the iris, after which the keratome is advanced deeper. Care should be taken not to injure the iris, which may happen if the tip of the keratome is not elevated sufficiently. Whatever the size of the keratome, the incision made will not be long enough; it can be enlarged with one of the cutting edges during the withdrawal of the instrument if the keratome is drawn out by moving it sideways instead of parallel to its length. The keratome should not be bevelled during this process so as to avoid a corneal incision. The section made by knife or keratome can be extended with scissors. One blade of blunt-pointed scissors is inserted into the incision with the scissors held parallel to the iris, and the blades then brought together (see Fig. 14*c*).

The section should be of adequate length, whatever instrument is used. A short incision can hinder delivery of the lens, making the procedure difficult (particularly with intracapsular extraction), and cause complications due to unavoidable exertion of force. A section made too large is a lesser evil; a section made too small is a great one.

Iridectomy and iridotomy. Each of these two procedures (the choice depends on the indications) is performed with a double purpose: to prevent incarceration or prolapse of the iris and to make lens delivery easier. Complete iridectomy, however, should be preferred.

As will be understood from the term itself, iridectomy comprises excision of part of the iris. The size and shape of the opening created vary.

Only a complete iridectomy is made at this stage of the

operation, peripheral iridectomy and iridotomy being employed after lens delivery. To avoid repetition later we shall describe all three variants here. Complete iridectomy is indicated when the iris is rigid (displayed by sluggish and incomplete dilation of the pupil), when glaucoma is suspected, when there is escape of the vitreous through the incision, when the lens is tremulous, with atrophy of the iris, in extreme age, with diabetes and certain other diseases, and with nervous patients.

Technique. When the section is completed and the sutures have been partly tightened, the surgeon passes the fixation forceps to the assistant and holding a closed iris forceps with his left thumb and index finger inserts it into the anterior chamber along the vertical meridian almost to the pupillary border. The blades of the forceps are opened and a small fold of the iris grasped with them. The fold is drawn out of the incision and snipped off with De Wecker's iris scissors or with thin scissors pressed to the eyeball across the incision (Fig. 15*a*). The coloboma thus formed has the shape of a keyhole, which is valuable both for optical and cosmetic reasons since its wider part is covered slightly by the upper lid. As soon as this manipulation is completed, the iris retracts into the eyeball by its own elasticity; if this does not occur, it is smoothed back into place as described later.

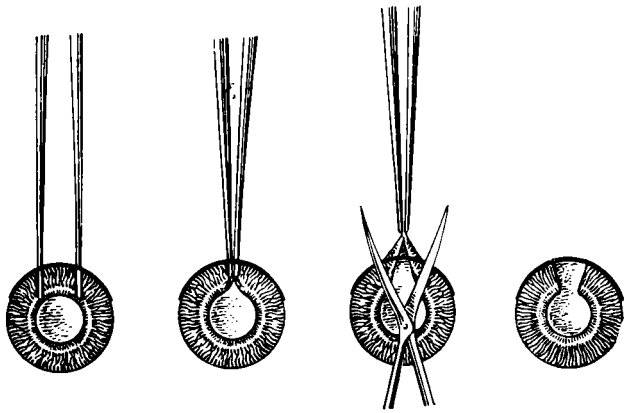


Fig. 15*a* Complete iridectomy

Apart from its valuable points, complete iridectomy has its shortcomings, the main one being an excessively wide pupillary opening, which causes extreme diffusion of light and dazzling.

The problem arises, whether it is possible to avoid this procedure and to perform a more rational manipulation instead. As already mentioned, an advantage of the method is that it provides for easy delivery of the lens through the pupil and prevents postoperative iris prolapse; but with maximum pupillary dilation the former condition is provided for. Iridectomy, however, is inevitable with rigidity of the iris, a condition that impairs mydriasis, contributes to postoperative prolapse, and makes retraction of the iris difficult on the operating table.

There remains the question whether only a complete iridectomy will prevent prolapse of the iris. Since it is the peripheral part of the iris that is mainly involved in prolapse, an opening formed there will suffice, and will exclude one of the factors contributing to this grave complication. The situation is as follows: aqueous humour passes from the posterior chamber into the anterior chamber through the pupil, and while circulating, bulges out the iris and tends to press it against the cornea and against the incision, causing the iris to slip through the incision; if a corresponding opening is made in the iris, the humour will seep through it and no pressure will be exerted on the iris. It was with that in mind that the idea of peripheral iridectomy, or a similar iridotomy, originated.

Technique. We would first remind that these procedures are performed *after* extraction of the lens. For peripheral iridectomy (Fig. 15*b*), the iris is grasped at its base at 12 o'clock with a slender iris forceps drawn slightly out of the eyeball, and cut off with scissors. Then it is reposited and smoothed out in the manner described later. With iridotomy (Fig. 15*c*), an incision about three millimetres long, radial or concentric with the limbus, is made in the iris with a Graefe knife or sharp-pointed scissors at a distance of 0.5 to 1.0 millimetre from its base. Further procedures are the same as in iridectomy.

Extraction of the lens. All previous stages of the operation may be called preparatory; this is the essential part. The ope-

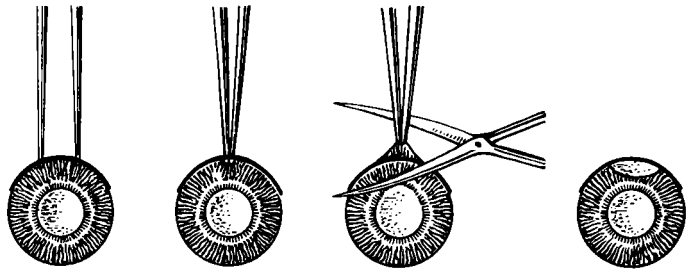


Fig. 15*b* Peripheral iridectomy

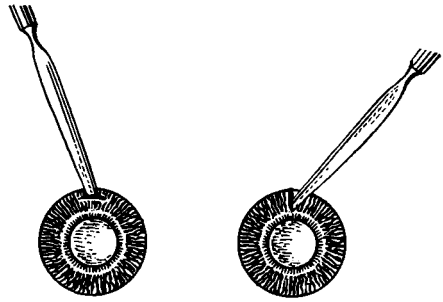


Fig. 15*c* Iridotomy

ration of intracapsular extraction of the lens has undergone a long and complicated course of development and perfection. Without counting the isolated attempts of various surgeons to remove a cataractous lens in the capsule, we may consider the method of intracapsular extraction to have been introduced by Pagenstecher (1871 and 1888) who either expressed the lens from the eye or removed it with a loop. The former method belongs to history and we shall not dwell on it. Here we shall concentrate on current methods one of which we shall describe in detail because, in our opinion, it is the most valuable. We have been employing this method ourselves since 1930, introducing certain improvements prompted by experience.

The method of intracapsular extraction described below is by rights named after its creator Stanculeanu (1912), and after Török (1916) and Elschnig (1932) who perfected it. In 1933, together with Varshavsky, we published data on 403 intracapsular extractions of the lens performed by a slightly modified method, which we both employed faithfully without changing it for others until more perfected, and in principal different, methods appeared (see below). We shall describe it in its final plan without dwelling on the history of its development and perfection. We have extracted about one thousand cataracts by this method. It has two variations: the first we use with a round pupil, the second in combined cataract extraction (with complete iridectomy).

(a) *Removal of the lens by tumbling.* We use the Arruga, Kalt, or Elschnig forceps to grasp the anterior capsule of the lens. The forceps blades have no hook but are shaped like spoons. The forceps is introduced close into the anterior chamber in a direction corresponding to the vertical meridian of the lens and is moved downward as far as possible to the lower pupillary margin with a wide pupil or under the iris with a smaller one and then is opened two or three millimetres (Fig. 16*a*). The forceps is inclined forward, their blades are pressed against the anterior capsule and then closed with a single quick movement. In most cases it will be seen that the capsule forms a fold between the blades.

An absence of blood in the anterior chamber is a prerequisite for a successful operation, otherwise all manipulations are conducted blindly since neither the forceps blades nor the capsule can be seen. Blood also makes the lens capsule smooth and slippery and difficult to grasp. Any blood, therefore, should be removed from the chamber with a jet of oxygen. It is difficult to indicate how much pressure should be exerted upon the capsule to grasp it adequately with the forceps. The feel for this comes quickly with experience, but one should be cautioned against pressing too hard since this may rupture the hyaline membrane of the vitreous along the line of least resistance, i.e. opposite the incision which may lead to the emergence of the vitreous into the anterior chamber or even its pro-

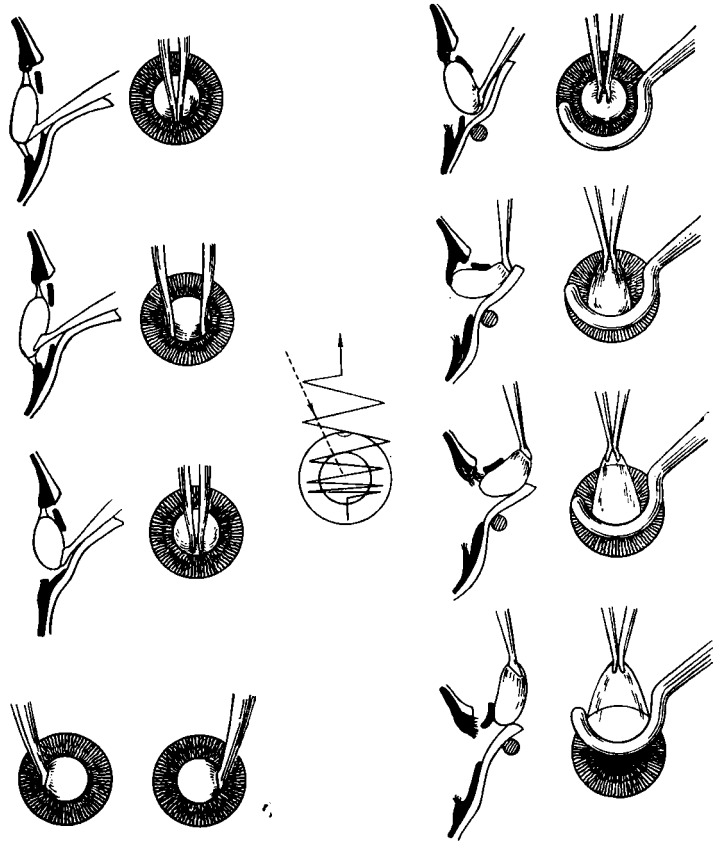


Fig. 16*a* Intracapsular extraction of the lens. First variant

lapse through the wound, in its pathology in particular. In such instances we withdraw the forceps and extract the lens with Weber's loop (see p. 130).

If the capsule is not grasped at once, we repeat the attempt, but not more than two or three times; and in case of failure abandon the intracapsular method and perform an extracapsular extraction.

Having made sure that a fold of the capsule is grasped with the forceps, the lens is rocked from side to side by the forceps for 15 or 20 seconds, the longer the better (the amplitude of the movement should be three to four millimetres). This is the principal stage of the operation, and has a double object: firstly, to rupture the zonular fibres, and secondly, to dislocate the lens from its lodgement in the fossa patellaris. When that has been achieved, it is lifted upward (forward) without ceasing the light rocking movements, while a directly downward pressure (backward) is simultaneously exerted upon the 6 o'clock limbus with a Daviel spoon or an Axenfeld strabismus hook.

As the forceps is gradually withdrawn from the wound with the lens hanging from them (the pupil immediately turning black), even pressure with the hook is continued, and it is moved upward along the cornea. By means of this double manoeuvre (mainly by the pressure on the cornea) the lens is tumbled through 180 degrees (see Fig. 16*a*) and the lower equator is delivered into the wound; if the lens is held in the wound, it is slightly rotated and, so to speak, slid out. Tumbling of the lens has two advantages: (1) while passing through the wound the lens stoppers it and prevents vitreous prolapse if the hyaloid membrane has been injured, and (2) the lens lower equator in moving forward does not have to pass or push out the upper part of the iris since it comes out through the pupil.

As soon as the lens has been delivered from the eyeball in this manner, we perform a peripheral iridectomy, as already described.

(b) *Removal of the lens by sliding.* The technique of extraction in an operation with complete iridectomy differs from that just described in that the lens is grasped by its upper equator and delivered from the eye without being tumbled (Fig. 16*b*). This, however, is not obligatory, as the lens can also be tumbled. In all other respects the procedures for extraction are the same.

Two promising advances of recent years have contributed to the method of intracapsular extraction, which we shall dwell on briefly.

Special instruments designed for intracapsular extraction

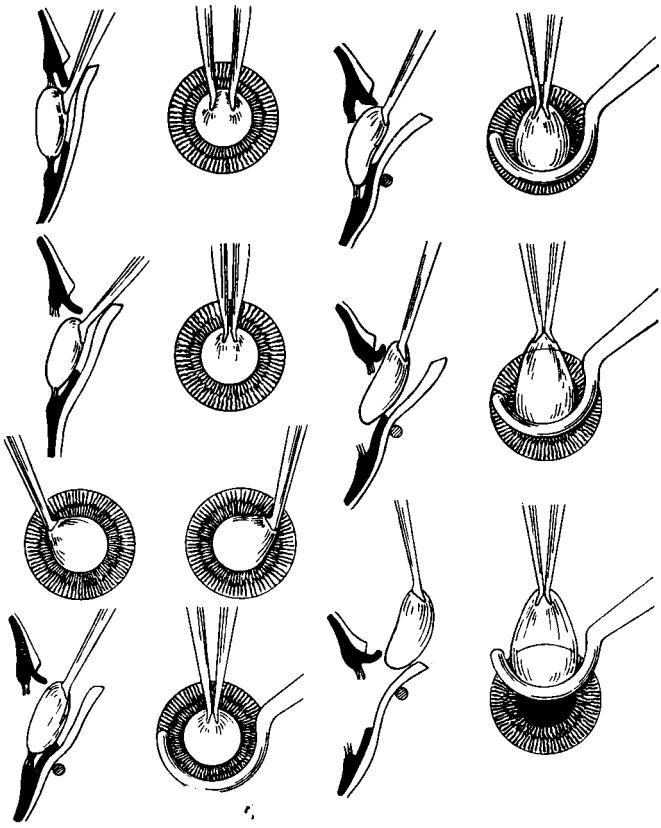


Fig. 16*b* Intracapsular extraction of the lens. Second variant

have gradually been introduced. One is the erysiphake which was used in the USSR for the first time by Tikhomirov (1956) and has found other devotees. Shmeleva (1963) reports 408 cataract extractions made with an erysiphake designed in the USSR, 95 per cent of them successful. The Bell erysiphake comprises a thin metal tube supplied at the end with a shallow cup 4.5 millimetres in diameter and a rubber bulb. Negative pressure occurs in the cup when the bulb is compressed, and as a result the instru-

ment acts as a suction pump. The section for introducing it into the eyeball has to be half the limbal circumference. The cup is introduced, with the bulb compressed, into the anterior chamber along the 6 o'clock meridian and fitted to the anterior lens surface at the centre or slightly higher. Then the bulb is allowed to fill out, sucking the lens to the cup; the erysiphake is then withdrawn from the eye together with the lens.

Use of the erysiphake is particularly indicated for the extraction of immature and intumescent cataracts with a tense capsule, and for hypermature cataracts with a fragile capsule.

Forceps should be used if there are signs of dystrophy because the erysiphake injures the corneal epithelium more.

The second advance is the use of alpha-chymotrypsin, proposed by Barraquer (1958). As has already been stated two factors hindering delivery of the lens within the capsule have to be overcome: the suction force adhering the lens to the vitreous body and the resistance of the zonular fibres. By destroying the latter alpha-chymotrypsin makes extraction much easier. The preparation is very valuable since it causes injury neither to the hyaloid membrane nor to the lens capsule; but its inability to destroy the synechiae and adhesions is a disadvantage. A solution of 1:5,000 alpha-chymotrypsin is injected under the iris and causes destruction of the zonular fibres in two or three minutes; it is then washed out of the eye with physiological solution. The lens moves forward, becomes spherical, and is easily removed with forceps or an erysiphake. Kymotraze (Walser, 1958) or trypsin (Hofman, 1959) may be employed instead of alpha-chymotrypsin.

Zonulolytic preparations have become very popular in the USSR. Protopopov and Murzin, Magilnitsky, Ferber and Kholmetskaya, and Danilevsky and Veremeenko reported on their observations at the Second All-Union Conference of Ophthalmologists held in Tbilisi in 1961. While expressing high approval of alpha-chymotrypsin, these authors urged precaution because it facilitates the development of such complications, as vitreous prolapse, dislocation of the lens from the vitreous, delayed healing of the wound and

refilling of the anterior chamber, etc. (Magilnitsky et al.). Similar data has been published by Zorab (1959), Radnot (1960), and others.

It has also been rightly pointed out by Arkhangelsky (cited by Protopopov and Murzin) that trypsin and chymotrypsin have a toxic effect on the tissues and may thus harm the ciliary body.

For all that, it may be supposed that, with the further experience and study of the action of these preparations, it will be possible to overcome their drawbacks and use them more widely.

An intracapsular extraction, however, does not always take a smooth course. Not only the first, but the second and even third attempt to grasp the capsule may sometimes be unsuccessful. Moreover, even when grasped, it may be impossible to extract the lens without rupture of the capsule, which may be due to two factors. (1) The forceps may loose its grip on the capsule as the lens is passing through the wound; in that case tumbling of the lens is assisted either with the forceps (with the blades together) or with another instrument pushing slightly at the lens equator without decreasing the pressure exerted upon the cornea with the hook (cup). A second attempt may also be made to grasp the capsule with the forceps. Intracapsular extraction can be successful even if the capsule is slightly ruptured: at worst, pieces of the capsule or small cortical remnants may be left in the anterior chamber near the wound or become incarcerated in the wound itself; they are easily removed by one means or another, and their remains will be resolved. In two or three days the eye will have the same appearance as one in which the extraction has been performed irreproachably. (2) For one reason or another the forceps may tear off a piece of the capsule. Intracapsular extraction then becomes a routine extracapsular procedure.

Thus, the lens may be delivered in an intact capsule hanging at the end of the forceps (+result)—this is the first possibility of an intracapsular extraction. The capsule may rupture as the lens passes through the incision but nevertheless is removed together with the capsule though a piece of the latter, or a small quantity of remains may be left in the eyeball (±result)—this is the second possi-

bility. Last, the capsule may rupture during the attempt to grasp it with the forceps, or a large piece may be torn off when traction is begun—the lens is then removed extracapsularly (—result).

EXTRACAPSULAR EXTRACTION

This method differs from the intracapsular only in the technique for removing the lens. The other stages are principally identical and there is no need to repeat their description. Attention will be concentrated on the techniques of the extraction as such, with a few remarks on other phases of the operation.

It should be noted, first of all, that the section made is somewhat smaller than that for intracapsular extraction since the lens is removed in fragments. Those who are against intracapsular extraction consider that the smaller incision is a great advantage of the extracapsular method. It is not the length of the incision, however, that is important (since it is closed either with sutures or with a flap), but its quality, its correct location, smoothness, etc.

As with intracapsular extraction, the pupillary opening must not hinder free and easy delivery of the lens. For that reason, either maximum dilation of the pupil should be achieved or an iridectomy performed.

The surgeon has to remove the lens completely from the eye in fragments. Even small amounts of lenticular or capsular remains can give rise to such postoperative complications as severe traumatic irritation, anterior uveitis, phacoanalytic endophthalmitis, infection, after-cataract, etc. An opening must be made in the capsule so that the lens nucleus and cortical material can be removed from it; the larger the opening, the better the procedure will be performed. The anterior capsule may be opened with two types of instruments. A cystitome or a sharp hook and the tip of a linear knife may be used. The cystitome is most frequently employed, the capsule being either opened crosswise, with two parallel incisions, or with incisions made in various directions. The second type of instrument is the capsule forceps, small but strong forceps supplied with three pairs of sharp teeth which grasp the capsule and tear a piece from it.

Either of these two types of instrument can be used, but it is best to use both simultaneously. The capsulotomy is performed as follows. The cystitome is introduced into the anterior chamber point-first with its blade parallel to the capsular surface, rotated around its axis so that its sharp edge faces downward, and is carefully inserted under the iris to the right and to the left, making a curved incision of 130 to 150 degrees in the lower and lateral portions of the capsule (without exerting pressure on the lens so as not to displace it). Then the forceps are opened as wide as possible, the capsule grasped with the teeth, the blades closed, and a large piece of capsule torn off. The nucleus and cortical material come out easily through the defect formed.

To illustrate the feasibility of the technique described some figures may be cited. We encountered an after-cataract in about 20 per cent of the cases where only a cystitome was used; the proportion dropped to 5 per cent when we began to employ the technique described above. Moreover (and this is no less important than the figures mentioned), the after-cataracts that occur following operations performed by this method are thin, frail, and semitransparent. They are simple after-cataracts which are such insignificant visual obstacles that they cause little loss of vision and do not require surgical treatment; furthermore, when an operation does have to be performed, it goes smoothly, as a rule, with no complications and excellent results.

Having removed the fixation forceps and slightly tightened the bridle suture, pressure is applied to the lower border of the cornea with a Daviel spoon. As soon as the upper border of the lens, its nucleus to be more precise, turns to the front the cornea is massaged slightly with the spoon and the nucleus extruded through the wound. This procedure is made easier by slightly depressing the scleral (posterior) lip of the wound with another Daviel or Hess spoon. After the nucleus has been expressed the eye is given one or two minutes' rest, carefully closing the lids and covering them with a moistened tampon. Then the cortical remnants are removed by means of two spoons as described above (Fig. 17).

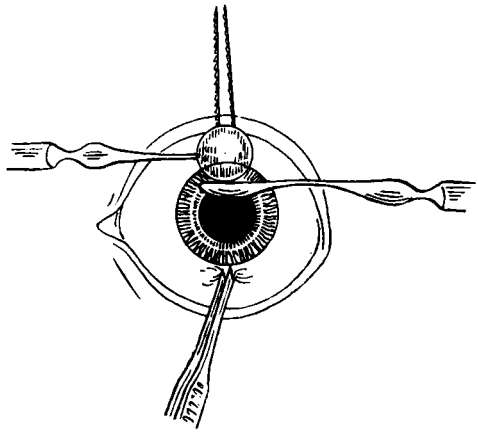


Fig. 17 Extracapsular extraction of the lens

If they do not come out, the spoon may be introduced carefully into the anterior chamber and the remnants scattered with the utmost precaution. That makes their removal much easier. Some surgeons express the remnants by massaging the cornea with the fingers through the eyelid. We do not apply this procedure because we consider it dangerous. Why should the injured cornea be massaged at random with the mucosa which may never be considered completely sterile, if the required result can be accomplished by means of a thin sterile instrument under visual control, the more since the procedure is more delicate than the relatively rough handling of the fingers?

It is not, however, always possible to remove all the remnants by these manipulations; some remain in the eye because of their viscosity and adhesive properties. The anterior chamber may then be irrigated (with great precaution) with a neutral (sic!) solution, preferably with an isotonic sodium chloride solution. A syringe is filled with solution (five to ten millilitres), fitted with a blunt cannula, which is introduced into the chamber; pressure is applied to the plunger while slightly depressing the scleral lip of the wound to make it gape. We employ a stream of oxygen

instead of this procedure on the assumption that the gas is no less efficient and much safer.

Any capsule revealed in the eyeball after removal of the nucleus and cortical remnants is extracted with forceps.

A black pupil does not indicate that all remnants have been removed. Lens fibres not involved in the opacification process may remain in the eye, particularly if the cataract was immature. They may be revealed when the interior of the eye is illuminated with an ultra-violet lamp the rays of which cause fluorescence of lenticular (but not of capsular) fibres.

Finally, it is necessary to warn against any overzealous action during removal of the nucleus and cortical remnants. The boundary between permissible and reasonable persistence and intolerable and dangerous obstinacy is very labile, and this may lead to severe after-effects in the form of complications.

The further stages of the extracapsular operation do not differ in any respect from the corresponding stages of intracapsular management.

Oxygen insufflation. The next stage of the operation consists in insufflation of the anterior chamber with oxygen. We apply this procedure whenever needed during any phase of the operation since its purpose is to prevent and eliminate any complications that may occur both during the operation itself and in the postoperative period.

The principal part of our oxygen device is an oxygen bag connecting rubber tubing to a soft rubber bulb. The other end of the bulb is joined to a second piece of rubber tubing with an insert of glass tubing 15 to 20 centimetres long loosely packed with sterile cotton. The cotton acts as a filter for any solid particles that may get into the system. It is well known that oxygen is abacterial; at high partial pressure it destroys unicellular organisms. The second tube has a cannula at its end fitted with a fine, truncated injection needle. Before use tube and needle are sterilized and wrapped in sterile gauze. When the bulb is pressed a continuous stream of oxygen escapes through the needle. One may dispense with the bulb, and exert pressure on the oxygen bag itself, but a bulb is preferable.

The mechanical action of oxygen. Premature escape of aqueous humour and emptying of the anterior chamber is an extremely unpleasant complication that can occur during the first stages of the operation, usually because of some technical error. It creates a certain inconvenience, mainly a decrease in the size of the operative field which flattens out completely. This condition can be managed by injecting oxygen into the anterior chamber.

Management of corneal retraction and collapse of the eyeball. This condition is familiar to every ophthalmologist and consists in a retraction of the central part of the cornea following incision of the chamber or delivery of the lens, as a result of which the cornea loses its characteristic convexity and becomes concave. If corneal retraction occurs at the end of the operation the procedures may be carried through to the end; but if it develops at the beginning of the operation all further manipulations on the eye become extremely difficult and may even be impossible. Completion of the operation has to be postponed, and there is no assurance that the complication will be avoided the second time. Early retraction is most frequently encountered with a fluid vitreous which escapes as soon as the eyeball is opened at the very beginning of the operation. One then has to deal with collapse of the entire eye rather than with retraction of the cornea. This is an alarming condition, due to its severe after-effects, and requires urgent measures.

Corneal retraction as such is no more than an inconvenience, but its consequences can by no means be considered innocent. If the edges of the wound are examined under a magnifying glass, especially with collapse of the eye, it will be seen that they gape slightly, or at best are poorly apposed if at all. Only the inner lips are usually approximated while the outer ones are more or less parted; a prismatic groove is thus formed with its apex pointing inward and its base to the surface. Its adverse effect can scarcely be exaggerated.

Inadequate apposition of the edges can give rise to unfavourable consequences, both immediate and delayed. The former include delay in refilling of the anterior chamber, incarceration of the iris, scraps of after-cataract membrane

and vitreous fibrils in the wound, and epithelial invasion of the anterior chamber, all of which add to the danger of infection already created by the incomplete apposition of the wound. Clinical and pathohistological studies provide sufficient evidence of the correctness of these statements.

The delayed consequences include complicated healing of the wound with the formation of a deficient scar, high astigmatism, etc.

Keratitis striae is encountered as a later complication of corneal retraction, one of its causes being the close contact between the endothelium of the posterior corneal surface and the anterior surface of the iris.

Introduction of oxygen into the anterior chamber eliminates all inconvenience and hazards associated with retraction of the cornea and collapse of the eyeball. It not only produces an effect during the operation, but also influences the healing of the wound. With reformation of the anterior chamber and restoration of the shape of the eyeball there is no longer any need to interrupt the operation. The wound does not gape, its edges become accurately apposed, and the possibility of the complications mentioned above developing is excluded.

The favourable effect of insufflation is supported by actual facts. Since we have employed this method as a routine procedure we have not once needed to interrupt an operation. We may also mention that we have encountered no unfavourable after-effects following loss of even large quantities of fluid vitreous. As a result we have always been able to perform all the manipulations necessary in the order required and to complete the operation. Neither have we encountered any unfavourable consequences due to inadequate apposition of the edges of the wound.

The incidence of postoperative keratitis striae observed by us has been relatively low, and no severe or protracted cases have been encountered. Finally, we also attribute the insignificant number of cases of postoperative astigmatism noted among our patients to the timely management of retraction and collapse and to the efficacy of the incision (smooth edges, short length).

Arrest of haemorrhage. To arrest a haemorrhage the tip

of the needle of the oxygen device is inserted into the anterior chamber and immediately directed as sharply sideways as the small point of entrance will allow. Then the needle is advanced until it almost touches the angle of the anterior chamber close to the puncture wound; it should be so held that the incision gapes slightly to facilitate the escape of blood from the eye. The stream of oxygen supplied under a certain pressure strikes against the angle and is reflected from it, mixes with the blood foaming it, and is expelled with the latter from the eye. Without ceasing the flow of oxygen, the needle should be moved from side to side so that the gas is gradually blown over the entire chamber and all the blood is removed. The chamber is then insufflated with oxygen to the full. In one or two minutes one can see whether the haemorrhage has been arrested and whether the operation can be continued and completed bloodlessly. With sufficient experience all further manipulations may be performed in such a way that the gas remains in the chamber. The procedure described is extremely efficient and no additional measures are required to arrest the haemorrhage or to remove blood from the chamber.

The haemostatic effect of oxygen in the anterior chamber may be attributed to the influence of mechanical and biochemical factors. Let us consider the former. In accordance with the known laws of hydraulics, gas in the cavity exerts a uniform pressure on all its walls, at the same time compressing their vessels. Since the action of the gas is continuous and of a long duration, the haemorrhage gradually diminishes and then stops. The method described is simple, safe, and reliable.

With the use of this procedure we no longer encounter expulsive haemorrhages. The absence of bleeding cannot be explained simply by the fact that it did not occur in this series of operations; we attribute it to adequate and thorough preoperative management of the patient, but mainly to the effect of oxygen which restores intraocular pressure on introduction into the anterior chamber, and reduces the hazards of haemorrhage ex vacuo, expulsive haemorrhage being such in nature.

Cleansing the incision and anterior chamber of strands of an after-cataract, lenticular remnants, and vitreous fibrils.

For this purpose we insufflate the anterior chamber with oxygen either during the operation or at the end of it, independently of whether there has been a haemorrhage. The procedure proves very effective for removing remnants of tissue whose retention is extremely undesirable, and saves any need to "catch" them with forceps (a manipulation that is usually quite unsuccessful) or express them by means of massage.

Replacement of the iris and prevention of its prolapse. Our technique for replacing the iris will be described later; by supplementing the procedure with the introduction of oxygen into the anterior chamber we have achieved even better results: the iris smooths out completely and holds firmly in place during the first postoperative days when there is most danger of prolapse. We should mention one detail which needs to be observed when introducing oxygen: the needle should be inserted into the chamber only when a continuous stream of gas is flowing from it. Thus oxygen will be blown over the operative field before the needle is introduced and at the moment of introduction. If complete replacement of the iris had not been achieved by previous manipulations, the stream of oxygen will cause it to retract into the anterior chamber, retire to its place, and to smooth out.

In support of the efficacy of this procedure, we may note that we have not encountered a single case of prolapse of the iris, or of its incarceration in the incision in the postoperative period, since we adopted insufflation as a routine manipulation.

Exclusion of the vitreous from the anterior chamber and its retention. Oxygen insufflation is perhaps most valuable of all to prevent the after-effects of vitreous damage, and of the ensuing constant tendency of the vitreous to advance and invade the anterior chamber. This in its turn may cause keratitis striae, an increase in intraocular pressure, and other complications. The possible development of a certain chain reaction cannot be ruled out: vitreous prolapse or vitreous loss, collapse of the eyeball, impairment of ocular nutrition, haemorrhage ex vacuo, and detachment of the choroid and the retina can occur. A simple enumeration of these conditions and of their severe after-

effects is alone sufficient to convince one of the extreme importance of any measure that holds the vitreous in place and compensates its loss by purely mechanical means even for a short period. Insufflation of the chamber with oxygen is just such a measure.

Any increase in intraocular pressure following an operation for after-cataract is probably due to the presence of vitreous in the anterior chamber. Oxygen introduced into the chamber will force the vitreous back, and eliminate this condition which is responsible for the development of secondary glaucoma.

To conclude our discussion of the advantages of using oxygen for vitreous retention, we would note that the procedure also prevents retinal detachment.

Finally, we must bring to attention an optical effect produced by introducing oxygen into the anterior chamber. The effect which has no influence on the condition of the eye, but may give rise to a certain misunderstanding, is as follows. The gas forms one or more double-contour bubbles in the chamber, which at first fill its whole, or almost its whole space, with restoration of the chamber, they become suspended in the aqueous humour and float in it. If the gas completely fills the chamber it is encountered in front of the pupillary opening; the same occurs in certain positions of the patient's head as the bubbles move about in the humour. A ray of light from the ophthalmoscope then causes almost no illumination of the fundus so that the latter's reflex is barely detectable. A sharp decrease in visual acuity occurs simultaneously in the eye.

This phenomenon may be explained as follows. The eye, even if aphacic, as in the present case, is a strong positive optical system. The presence of a gas bubble in front of the pupillary opening is the same as if a strong negative lens were introduced into the system, and is responsible for the change in the direction of rays, which in turn causes the disorders described. The correctness of this explanation is easily verified by placing a strong biconvex glass before the eye affected: the fundus becomes visible and visual acuity increases.

The biochemical action of oxygen. There is no doubt that oxygen exerts a biochemical as well as a mechanical effect,

The former is displayed in three aspects: haemostasis, resolution of pathological products, and diminution of inflammatory phenomena.

Haemostatic effect of oxygen. A stream of oxygen directed at a bleeding vessel will arrest the haemorrhage within several seconds; what is particularly interesting is that the bleeding will not usually recur, which provides evidence of the biochemical action of oxygen.

Resolvent effect of oxygen. The physical conditions under which oxygen remains in the anterior chamber are basically more or less the same. Its rate of resorption, however, varies with each case, in the following way: the smaller the quantity of pathological products (blood, lenticular and capsular remnants, pigment cells, etc.), the slower the resorption (the gas may sometimes persist in the chamber for 96 to 120 hours); the greater, however, the quantity of products, the faster the loss of gas (in as little as 24 hours).

Interacting with the pathological products and undergoing resorption, oxygen also facilitates the irresolution; their quantity becomes less with each change of dressing. The phenomenon is easily explained: any pathological condition is attended by tissue hypoxia; the greater the quantity of pathological products, the more oxygen is required and utilized. Thus, the rate of oxygen resorption serves, as it were, as an indication of the severity of the inflammatory tissue reaction. This is the second aspect of the biochemical action of oxygen.

Anti-inflammatory effect of oxygen. By removing the pathological products from the anterior chamber, oxygen reduces the inflammatory tissue reaction excited by the operative trauma. Inflammation rapidly subsides.

Subconjunctival injection of adrenalin. As a rule, we make this injection without fail whenever there are no contraindications (advanced age, increased arterial pressure, etc.). Adrenalin injected (0.1 millilitre of a 1:1,000 solution) with all the necessary precautions should excite no fear of complications. But if, nevertheless, a reaction due to severe constriction of the vessels occurs (sudden pallor of the face, mild dizziness) it is quite sufficient to let the patient inhale ether (on moistened cotton) for several seconds for the symptoms to disappear without trace.

We attach great importance to maximum dilation of the pupil on the operating table and during the postoperative period, for the following reasons in particular. Firstly, incarceration of the advancing vitreous in a narrow pupil may occur which will result in an increase of intraocular pressure; the wider the pupil, the less chance there is of this occurring. Second, any trauma, however slight, associated with the operation will cause a certain stimulation, albeit insignificant, of the anterior segments of the eye. This alone requires that the iris be set at rest, which is ensured by its maximum contraction.

Toilet of the operative field. We cleanse the operative field (the final stage of the operation) with a stream of a cool, sterile, neutral solution (physiological solution of sodium chloride, a weak solution of soda or boric acid, etc.) directed at the eye from an undine held at a height of 15 to 20 centimetres. This simple and safe manipulation performs several functions: (1) it removes all foreign particles retained in the conjunctival sac (blood clots, strands of lens capsule, cotton fibres, etc.); (2) it sets in place and smooths out the conjunctiva; (3) it facilitates contraction of the tissues, through the force of its action and its relatively low temperature (usually room temperature). Owing to the contraction of the tissues the iris retracts into the eye and there is no need to use a spatula to replace it; and hence there is also no hazard of introducing infection and inflicting trauma, while the wound edges become adequately adapted. Irrigation has yet another advantage: it arrests bleeding from the vessels of the conjunctiva and iris. (Although it has already been said that the principal means of haemorrhage arrest is insufflation of the anterior chamber with oxygen, this supplementary measure should not be disregarded.)

Use of a spatula to replace the iris nevertheless cannot be completely avoided, and this manipulation, traumatic however delicately performed, has occasionally to be applied (with marked rigidity of the iris, and certain other conditions). It is performed in the following manner. The sterilized spatula is held parallel to the plane of the iris, and almost parallel to the length of the incision and is introduced very carefully between the lips of the wound

into the anterior chamber; then the iris is smoothed out by carefully moving the spatula over its surface. The manipulation is repeated at the other end of the incision, without withdrawing the spatula from the anterior chamber.

We paint the wound with tincture of iodine as an additional measure of disinfection. Our experience shows that in addition to this purpose, the iodine causes immediate apposition of edges of the wound visible to the eye, owing to its marked astringent properties. The response to treatment with iodine is limited to these phenomena. We have never encountered any irritating effect of iodine if the eye has been previously anaesthetized. Toilet of the operative field is completed by introducing into the conjunctival sac two or three drops of 1 per cent atropine, two or three drops of 20 per cent albucid (sulphanil acetamide), of penicillin (100,000 U in ten millilitres of a 0.5 per cent novocain solution), of 2 per cent amidopyrine solution in 1:5,000 furacilin, or of some antibiotic.

Both eyes are then covered with a dry aseptic cotton-gauze dressings and the patient is wheeled to the ward and carefully put to bed. We consider it advisable to cover the second eye so as to create a restful regimen for the one operated on, and partly, so that the patient will realize that he has undergone a serious operation and needs complete rest. We relax this rule only with patients in whom covering of the second eye causes discomfort. It is advisable to fix the dressings to each eye with separate bandages, since the second eye can be uncovered 24 hours after the operation, particularly if it retains any vision, though it may be still too early to change the dressings on the eye operated on.

We have described all the stages and phases of the operation for senile cataract in such detail, that our discussion of extraction of other types can be limited to an explanation of the deviations from the typical procedures and methods that are used for each type.

B. Cataracts due to Endocrine Dysfunction

The operative technique does not differ from that for senile cataract. It should, however, be stressed that these

patients require particularly careful management as bodily resistance to harmful factors is reduced in *diabetics*. They have a tendency to haemorrhages, and inflammatory processes, including suppurative ones, develop easily. This dictates insistent need for extremely thorough and sometimes prolonged preoperative management so as to achieve a state of possible compensation of sugar metabolism, normalization—even if incomplete—of the blood sugar content, control of acidosis, etc. With patients with *tetany* measures should be applied so that no manifestations of the principal disease will occur. Fulfilment of these requirements must be done in consultation and cooperation with an endocrinologist.

Meticulous attention should naturally also be given to postoperative management, all the points mentioned above applying to this period as well.

C. Congenital Cataracts

Surgical intervention for a congenital cataract is recommended only with severe loss of vision; the indications are considered individually.

Lamellar cataract. Surgery is indicated only when vision is so low that it affects the patient's development, behaviour, work, etc. The approach to the problem must be individual. The operation should not be hastened if a child's vision suffices for its needs (allows the child to move about easily, take part in games, etc.) and there is no danger of torpor retinae. With time, in the pre-school period the child's needs advance, and by the time he goes to school the problem of removing the visual obstacle arises. There are two ways to solve this problem. It is not necessary to extract the lens; since its peripheral parts are transparent, as a rule, visual acuity may be improved by performing an iridectomy, if the eye is not amblyopic, of course. Before deciding on operation, however, its prognosis with regard to visual acuity should be evaluated. This may be done by the method that we had conceived many years ago and which we have employed whenever indicated (central cataract, central leukoma, etc.). A sub-

conjunctival injection of 0.1 millilitre of 1:1,000 adrenalin is made at the 3:30-4 o'clock on the limbus of the right eye, or at the 7:30-8 o'clock limbus in the left eye. Several minutes later, the pupil begins to stretch out along the meridian at which the injection was made, and ten or fifteen minutes later a phenomenon resembling coloboma of the iris occurs which simulates a genuine post-iridectomy coloboma. Determination of the visual acuity in this condition will show what results we may expect of an iridectomy made at the above-stated sites of the iris and whether the operation will be of practical value. Amblyopia can be suspected if removal of the visual obstacle will give little or no improvement of visual acuity. But this should not be taken as a contraindication for iridectomy: modern methods of increasing the visual acuity of amblyopic eyes, particularly in children, produce excellent results; for that reason, an attempt to provide such a patient with vision should nevertheless be made. A narrow iridectomy (without resecting the root of the iris) should first be made, followed by one or more courses of treatment of amblyopia.

The account given above makes it clear that iridectomy is indicated where it removes an obstacle that impairs good vision. The cataract has to be extracted if the lens is opaque at the site of the future coloboma. In our view it is the localization of the opacity and not its extent or the visual acuity that is the principal and final criterion of the choice of operation—whether it is to be an iridectomy or a cataract extraction. With the latter the question then arises by which method the lens should be extracted. There are two ways, differing markedly one from the other.

The first method, and that the most feasible, in our opinion, consists in removal of the lens in that state in which it occurs. The second method comprises two stages: (1) preliminary dissection of the capsule and (2) removal of the lens.

Lens extraction may be performed either by the intracapsular or by the extracapsular method. We recommend a technique as follows. Children should be operated on under general anaesthesia, adults under local anaesthetic, after being prepared according to the rules already described with modifications for age where necessary. The operation itself

is a simple linear extraction. We attempt an intracapsular extraction. Should the capsule rupture (which frequently happens with this type of cataract) we try to tear off as large a piece as possible, having first made sure that an intracapsular procedure cannot be performed; in other words, we change from the intracapsular to the extracapsular technique, and complete the operation as such.

We would repeat that extraction of the lens by one or other of these methods is the operation of choice for a zonular cataract.

Another method of surgical management does exist, as we have already mentioned: discission of the cataract. We shall describe it very briefly, because we do not recommend its use. It is made with maximum pupillary dilation.

Technique. Neither acinesia nor a bridle suture is required. Instillation anaesthesia with 0.5-1 per cent dicaine solution. Fixation of the right eye at the 4:30 o'clock meridian, of the left at the 7:30 o'clock meridian. A discission needle, a thin linear knife, or a special Knapp knife is thrust into the conjunctiva of the upper external segment of the eyeball three or four millimetres from the limbus.

The instrument is introduced into the anterior chamber and advanced flatwise to the pupillary margin lying opposite to the point of entrance. Then with the tip of the needle (knife) inserted into the lens, the capsule is dissected first in one direction and then in several others, after which the instrument is withdrawn. With that, the operation is completed.

Within the next few days the lens fibres swell, become opaque and gradually undergo resorption. The remnants, however, may swell so rapidly as to give rise to phacogenetic endophthalmitis; healing of the capsule incision is also encountered. In both cases paracentesis has to be made and the remnants evacuated. The need for a second operation also occurs with slow resorption of the lenticular remains, and may be suggested by the desire to assist the patient's vision as quickly as possible.

All this persuades us, and a great many other surgeons, to abandon discission as a method of operation for a zonular cataract; the possibility of performing an extraction by means of the erysiphake or cryoextractor firmly settles the problem in favour of the intracapsular procedure.

The correctness of this approach has been shown by the final results of cataract extraction and cataract discission. Chechik-Kunina (1940), for example, obtained fairly good vision (above 0.1) in 63.4 per cent of patients following extraction and in only 13.6 per cent following discission.

Soft cataract. The difference between the methods and techniques of extraction for senile and for soft cataract is dictated by the age peculiarities of the eye tissues and structures, particularly of the lens. A soft cataract is a privilege of the young; with it the nucleus is either absent or is present in a rudimentary state.

When performing the operation, all the general principles previously discussed should be observed.

The pupil should be dilated to the maximum. The length of the section can be relatively short: it is made with a linear knife or a keratome at the border of the inner limbus. The use of scissors, the application of sutures, the creation of a flap, and iridectomy are usually unnecessary, but not contraindicated. A flap is made when adequate relative sterility of the conjunctiva is doubtful. There is no need for either iridectomy or iridotomy if the iridic tissues are elastic and show no tendency to prolapse.

The capsule is opened with a cystitome by incisions made in several directions, and the lens matter is expressed by means of two spoons as described before.

Because the operative procedures do not include iridectomy, there is increased danger of iris incarceration or prolapse. Therefore some miotic should be introduced into the conjunctival sac.

OPERATIONS FOR COMPLICATED CATARACT

Myopic Cataract

We have already stated that not every cataract occurring in a myopic eye should be considered myopic. It may be a senile cataract developing in a near-sighted eye. We shall deal here with the surgical treatment of myopic cataract described in Chapter 2; but all the principles discussed hold as well for a senile cataract in a myopic eye.

Cataract extraction in high myopia is specific owing to the peculiarities of the myopic eye and of the cataract; viz. a relatively large nucleus, a pathological condition of the vitreous (fluid vitreous), degenerative changes in the retina and iris, and slow maturation of the cataract.

Something like a chain reaction is encountered here: the large nucleus requires a section longer than commonly made, while longer section may give rise to vitreous prolapse. That in turn increases the hazard of retinal detachment. The patient meanwhile raises the question of operation because, myopic cataract being nuclear, as a rule, with the opacity involving the central parts of the lens, and both eyes not infrequently being affected, he becomes incapacitated in spite of the fact that a larger (but peripheral) part of the lens is transparent.

The only way out is to extract the immature cataract. The method of choice, intracapsular extraction, stems from the condition of immaturity as such.

The complications following intracapsular extraction by an experienced ophthalmologist, as we have already said, are no greater and no more serious than those occurring after extracapsular procedures (despite the opinion of some surgeons whose view, to our mind, is not supported by sufficiently forceful data). On the results of 403 intracapsular extractions we (Varshavsky and Rabinovich) wrote as early as in 1933 that "intracapsular extraction is particularly advisable for myopic cataract.... As to vitreous loss following removal of the myopic cataract, our experience is that, with due precautions, this hazard is no greater than with extracapsular extraction". Our experience allowed us to conclude: "Intracapsular extraction is absolutely indicated ... for myopic cataracts and complicated cataracts in general".

In the more that thirty years since that was written, our further experience has not only given no reason to change our opinion, but has confirmed its correctness.

A brief case-history is presented in illustration.

R. S., a 65-year-old female patient. Myopia of 12.0 D. Nuclear myopic cataracts in both eyes. Visual acuity in the right eye (with correction) 0.06, in the left, 0.03. Intracapsular extraction per-

formed on the left eye. No complications encountered either during the operation or in the postoperative period. Patient discharged on twelfth postoperative day with visual acuity of 0.3 without correction. Ten weeks later visual acuity increased to 0.6.

We are not alone in our opinion that intracapsular extraction is the most advisable operation for a myopic cataract. Vasilevich (1961) presents convincing data in its favour. Intracapsular extraction was performed on 47 patients (52 myopic eyes) by the method suggested by Zolotareva, Birchenko, and Vasilevich. Most of the cataracts were immature. Typical details of the operation were: conjunctival flap, mattress corneo-episclero-conjunctival suture, iridectomy; the lens was delivered by intracapsular expression by means of a loop or spoon. Though these manipulations entail great risk of complications, the latter did not exceed those commonly encountered, either in quantity or in quality. Remote follow-up showed the results of surgery to be most favourable. We may cite one as an example: a visual acuity of 0.6 to 1.0 was encountered in 12 of 30 eyes even in cases of high myopia.

Cataract in Association with Retinal Pigmental Degeneration

Before deciding to extract a cataract, one should determine the condition responsible for the decrease in visual acuity, whether it is a central cataract or changes in the retina. The tragedy of such situations is that the active region of the retina is located behind the opacity, while its peripheral sections lying behind the transparent parts of the lens do not function. Whatever the case, the pupil has to be dilated and visual acuity determined in mydriasis. An operation mainly has to be made for immature cataract.

The presence of degenerative changes in the retina makes the operative prognosis doubtful. In spite of that, surgery is indicated when visual acuity is not less than 0.1 and the fundus cannot be examined in detail without dilation of the pupil; central colour vision should be retained, the projection of light should be accurate along all meridians to at least 15 degrees from the point of fixation.

Cataract and Retinal Detachment

The problem of cataract extraction and retinal detachment has two main aspects: (a) conduct of the operation in conditions that can contribute to occurrence of this complication in the postoperative period, and (b) extraction with the detachment already present.

The danger of post-operative detachment of the retina seems very great to us, first of all, in situations where a non-traumatic detachment has already developed in the other eye, previously operated on. This fear is justified since both eyes, as is well-known, usually react in a similar manner to the trauma caused by an operation, both during the procedures and afterward. Secondly, pathological conditions in the eye to be operated on (high myopia, cystic retinal degeneration, etc.), which facilitate detachment of the retina, are also a hazard; their presence may normally be recognized from the patient's case history.

From fear of these complications Franceschetti (1955) proposed, not without reason, a prophylactic barrage of the two upper retinal quadrants in such cases, while Callahan (1958) recommended non-perforating diathermocoagulation of the sclera along its entire circumference posterior of the ora serrata. We consider those preventive measures both reasonable and feasible. Neither the presence of retinal detachment, nor the possibility of its development, is an absolute contraindication of extraction; the operation should be carried out with the utmost precautions, especially when detachment has already occurred. We were able to achieve relatively good results in three cases with traumatic retinal detachment (Rabinovich, 1961), improving visual acuity from uncertain light projection to 0.06 in one patient, and from 0.005 to 0.06 and from 0.01 to 0.08 respectively in the other two. The adequacy of management involving first cataract extraction and then an operation for retinal detachment is confirmed in the literature (Forest et Haut, 1966, and others). It is of no little significance that removal of the cataract allows to reveal the detachment.

Cataract Caused by Uveitis

As objects of surgical intervention this group of cataracts

includes those occurring in an eye which has previously suffered from uveitis (extraction of a cataract during inflammation of any part of the uveal tract is absolutely ruled out).

All aspects of surgery should be carefully considered prior to the operation. First of all, there must be complete certainty that there is no hyper-sensitivity, either general or local, and particularly no specific hyper-sensitivity (tuberculosis, allergy, etc.); then the most active measures should be applied to normalize the condition both of the entire body and of the organ of vision, in other words, the patient must be carefully prepared for the operation.

Particular attention needs to be paid to examination of the eye, since the choice of operative method depends on the character and severity of the pathological changes caused by uveitis. The changes usually comprise remains of an exudate that has undergone organization, and displayed in various forms from thin, separate posterior synechiae to circular adhesions of the pupil and its complete closure.

The quantitative and qualitative differences of these pathological changes must be considered. A few thin posterior synechiae can probably be disregarded and the cataract treated surgically as a simple cataract, because they will rupture during its delivery. Stronger adhesions require additional manipulations.

For a number of years we have used the following method for cases with a relatively small number of synechiae. The first stage of the operation (preliminary procedures) does not differ from a routine cataract extraction. The limbus is punctured with a thin, narrow linear knife held with its blunt edge to the operator; the tip of the knife is inserted carefully under the iris, and all adhesions are dissected by rotating the knife around its transverse axis at the point of insertion. With adequate speed and accuracy of movements escape of aqueous humour and injury to the lens capsule are usually avoided. The knife is then turned 180 degrees around its long axis and a counterpuncture is made. This is followed by a section. An intracapsular extraction is preferable because the lenticular remains left after an extracapsular extraction and the pathological products formed during uveitis may cause inflammation of an eye sensitized by uveitis: a flare-up of

sympathetic ophthalmia is particularly dangerous. If intracapsular extraction proves unsuccessful and the capsule ruptures, the opening should be extended as much as possible and the lens removed by the extracapsular technique.

Extraction of the lens is preceded, as a rule, by complete iridectomy performed by any of the accepted methods. This is valuable for two reasons: firstly, removal of the lens, a complicated procedure in this condition, becomes much easier; and secondly, iridectomy is known to exert a certain antiphlogistic effect. In compliance with Graefe (1856), who was the first to perform an "antiphlogistic" iridectomy, the procedure used to be considered to affect the inflammatory process proper by weakening it and even preventing new foci. The significance of iridectomy is evaluated in a rather different manner now, its action being attributed mainly to prevention of an increase in the intraocular pressure that often accompanies uveitis. In any event, it is necessary in such cases.

The problem is whether to carry the operation out in one stage or in two, i.e. to make a preliminary iridectomy and then extract the cataract some time after. Each method has its pros and cons. Each phase of a two-stage operation may by itself be a milder intervention than a combined operation, but which will inflict less trauma—two relatively mild operations or a single more severe one—should be decided individually for each patient. The decision rests on the surgeon's experience and knowledge.

The following consideration may be of some importance when deciding this point: the relatively mild damage suffered by the eye during iridectomy can be taken as an indicator of the eye response to a trauma (so-called reconnaissance iridectomy). It will give some idea of how the eye will respond to removal of the lens and so give warning of the unexpected. It should not be forgotten, however, that at our disposal powerful antiphlogistics are available that can control and suppress the hyper-sensitivity spoken of; consequently, only relative importance may be attached to this "reconnaissance".

Iridectomy may be impossible in very severe cases with circular adhesion or complete closure of the pupil, so that Wenzel's operation has to be made, as follows. After the ap-

propriate preparations, a narrow linear knife is inserted at the usual site; when its tip appears in the anterior chamber it punctures the iris, advances through the surface layers of the lens, and makes a counterpuncture involving the iris and eyeball. Then a section is made, opening the eyeball and resecting a segment of the iris together with part of the lenticular anterior capsule adherent to it. The coloboma of the iris is then shaped as required with forceps-scissors and the lenticular nucleus and remnants are removed in the usual way.

The operation is recommended only when no other method can be employed; it should be remembered that it rarely goes smoothly. Haemorrhage from the iridic vessels is almost unavoidable, and the other severe complications described in Chapter 7 are encountered very often.

Cataract in Association with Glaucoma

In our discussion of the various types of cataract we mentioned that cataract and glaucoma may occur together in an eye in two variants: glaucoma in a cataractous eye and cataract in a glaucomatous eye.

The surgical tactics and operative technique differ with the condition, and they must therefore be discussed separately.

Glaucoma in a cataractous eye. Surgery has to be resorted to if attempts to reduce persistently high intraocular pressure by other methods (miotics, diamox and its analogues, etc.) have proved ineffective.

Since these cases call for a combined cataract extraction it is best to perform a complete (and quite extensive) iridectomy, which will achieve two purposes. Firstly, the intraocular pressure will be reduced and will be easier to regulate later by non-surgical measures; secondly, an important stage of cataract extraction will have been accomplished in advance and the operation will be made simpler.

Other anti-glaucoma operations are less advisable under these conditions, since they serve only the first purpose.

When non-surgical measures reduce intraocular pressure, there is no need for an urgent anti-glaucoma operation, and it is possible to await the course of events, taking care

to maintain pressure at not very high levels. It is best to extract the cataract as soon as possible because there is a danger of gradual impairment of visual functions and loss of photoperception even when pressure is not very high.

Still less should the operation be postponed if iridectomy has not been performed for one reason or another (the state of decompensation having been relieved by non-surgical means, the patient declining the operation, etc.). The cataract may be removed by one of two techniques in such. The first comprises two stages: (1) preliminary iridectomy, and (2) extraction of the lens two or three weeks later, but not earlier. The point and purpose of a two-stage operation is to deliver the lens from an eye in which the pressure is normal or at least not very high; but it is gradually falling into disuse. With the agents now available to reduce intraocular pressure single-stage operations can be performed which save the patient from making two trips to the operating table. The procedure is as follows. A few days before surgery miotics are prescribed amply and the dose of diamox is increased (to 500 milligrams given several hours before the operation). The operation is performed under retrobulbar anaesthesia (four to six millilitres of a 2 per cent novocain solution, plus 25 units of hyaluronidase); 0.1 to 0.2 millilitre of 1:1,000 adrenalin is added in the absence of contraindications. Should the decrease in intraocular pressure be insufficient in spite of the measures applied, the conventional cataract extraction is preceded by some type of anti-glaucomatous operation: anterior sclerectomy, posterior trephination of the sclera, iridencleisis, cyclodialysis, etc. An additional measure to ensure safety in the period between the two phases of the operation is a rest of two or three minutes so that the eye can become adapted to the new conditions. The procedures as such should be made at the usual speed—quickly but not hurriedly.

Satisfactory results can be produced from this technique, as regards both normalization of intraocular pressure and adequate improvement of visual acuity.

Cataract in a glaucomatous eye. The surgical tactics for extraction of a cataract from an eye affected with primary glaucoma vary with the case and the conditions. They are similar to those for removal of a cataract from an eye suffer-

ing from secondary glaucoma discussed above, but quite different when the cataract has to be delivered from an eye that has undergone a fistulization operation.

The site of the incision has first to be considered. It is simpler when made in the limbus through the filtering bleb (first variant), but practice has shown that this method will only produce good results with low intraocular pressure. The operative technique does not differ from the normal procedure.

The second variant is an incision made through the cornea anterior to the bleb. The advantage of this site is that the disturbance of corneal nutrition caused by the incision is confined to the small segment where both operative wounds were made. It should be noted that the overhanging corneal shelf formed by this incision creates certain difficulties for lens removal, but, as Callahan says, "this is largely psychological".

With the third variant, the incision is made at the limbus laterally and below. With this incision no shelf is formed, but there is a danger of trophic disorders in the cornea because the operative wounds are made in two different places.

Cataract in Heterochromia Iridis

We single out this type from the other cataracts of uveal origin because it differs somewhat in surgical management. While the typical uveal cataract occurs in plastic uveitis, cataract in heterochromia accompanies serous iritis as an ingredient of the triad characterized by heterochromia, cataract, and precipitates on the posterior corneal surface. As a rule, there are no adhesions. Surgery is performed in the usual way. The operation and the postoperative period are normally more or less smooth, but exceptions may be encountered. We had one such case among a large number of extractions for cataract in heterochromia.

G. R., 36, female, a doctor. Generally healthy. Combined intracapsular cataract extraction performed without complications. The postoperative period was promising at the beginning but a violent reaction occurred on the seventh day in the treated eye, exhibited

by pericorneal injection, constriction of the pupil, haemorrhage in the anterior chamber, and the appearance of precipitates that had scarcely existed before the operation. With active antiphlogistic treatment the reaction subsided as rapidly as it had developed.

Although such cases are seemingly quite rare, their occurrence should be considered before beginning an extraction in heterochromia and the surgeon should be on the alert for them. It has to be especially borne in mind that a classic symptom of heterochromic cataract is an abundance of newly-formed blood vessels in the chamber angle at the root of the iris, which bleed readily.

Traumatic Cataract

Perhaps one of the most essential points to be considered in the surgical management of a traumatic cataract is when should the operation be performed. The former view that many months should elapse to allow the reaction of the eye to the trauma to subside, has given way to a well substantiated conviction that early operation is most expedient. We share this conviction (Dyment, 1960; Zolotareva and Kopp, cited by Dyment; Gundorova, Fridman, Morozov, and Polyakova, 1963).

A reaction to trauma is inevitable and it is inadvisable to wait till it ends since it can take a severe course in some cases (phacogenetic endophthalmitis, secondary glaucoma, complicated after-cataract, etc.) and reduce the hopefulness of the operative prognosis. Early operation for a traumatic cataract is by way of being a prophylactic measure against complications, particularly against after-cataract.

The expedience of early removal has been shown by experimental data. Activization of the reticulo-endothelial system, in particular of the ciliary body, is a response encountered with various types of trauma. The condition of this system can be regarded in a way as a test to evaluate the inflammation. The reaction usually develops eight to ten days after the trauma (even earlier in some cases), subsides by the end of the first month, and ends (approximately) at the end of the second month. Thus, the following tactics are the most feasible: a traumatic cataract should be removed within a week of the injury being sustained; where

this is not possible for one reason or another the operation should be postponed for at least two months.

An exception to that rule, however, has to be made when the reaction is displayed in the form of phacogenetic endophthalmitis and takes a violent course due to swelling of the injured lens. In any case, our first concern is to eliminate the inflammatory phenomena either by therapy (corticosteroids, amidopyrine, phonurite, oxygen, etc.) or by surgery.

The possibility of resorption of the cataract also needs to be considered: the younger the patient and the larger the defect in the anterior chamber of the lens, the greater the chance that resorption will occur. It is not advisable, however, to cherish much hope of this process, for the following reasons: it takes a long time; the resorption is arrested if the capsular defect heals, but even if there is no healing and the process continues it may not always be completed and an after-cataract may form, most frequently a complicated one; this in turn may call for an operation that may be more complex than that required for the primary traumatic cataract. We do not mean by that to imply that active measures should not be taken to stimulate the resorption when the time for an early operation has passed and one is obliged to adopt temporizing tactics (in the young, in cases when the defect in the lens capsule does not close, and under certain other conditions).

The choice of an adequate method for any case depends on a number of local and general factors: the character and severity of the injury, the reaction of the eye to the trauma, and the age and physical condition of the patient.

It is easier to read a decision with regard to a cataract due to contusion. It is best not to remove the lens if the cataract is partial, impedes visual acuity only slightly, and involves no cosmetic impairment, and if the eye is quiet, bearing in mind, in particular, the liability of severe aniseikonia in unilateral aphakia.

The method of extraction of a complete contusion cataract varies according to its features. We include it among the complicated cataracts, but the degree of "complication" varies. It may be displayed only by hyper-sensitivity and hyper-reactivity of the tissues; in more severe cases the

trauma may give rise to inflammation with the formation of posterior synechiae.

For the first type the operative technique is the same as for the extraction of a simple cataract, consideration being given to the patient's age, and particular precautions being taken against the possible occurrence of various complications caused by the trauma itself (vitreous liquefaction, tendency to haemorrhage, etc.). If a foreign body is revealed in the lens, an intracapsular extraction together with this body is preferable. With an extracapsular extraction, either planned or unplanned (i.e. an intracapsular extraction with a negative result), the lenticular remains should be thoroughly examined to make sure that the foreign body had been removed with them. It may be removed from the eye by means of a magnet when magnetic, but this is hardly necessary.

Radiation Cataract

We would supplement the characteristics of a radiant cataract with data that could be of importance in its surgical management. The anterior capsule of the lens is very fragile and tears easily when grasped with forceps and especially when it is sucked in by an erysiphake. This is unfavourable for the following reasons: radiation cataract occurs in the central part of the lens, and therefore significantly impairs visual acuity in its very initial stages. This peculiarity calls for intracapsular extraction of an immature cataract and the success of the procedure is largely predetermined by the strength of the capsule. As if in compensation for this deficiency, the zonular fibres are pathologically fragile in radiation cataract which should be considered a favourable factor for intracapsular extraction. Thus success of the operation depends upon the resultant of the two factors, positive and negative.

Shevalyov (1961) performed intracapsular extraction of a radiational cataract on seven patients, improving visual acuity to 0.75-1.0.

When a patient is being prepared for operation it must not be forgotten that the cataract is very probably not the only manifestation of the radiation sickness and that other organs and systems may be involved. These possible affections

should be revealed and all necessary measures applied. After proper preoperative management, the cataract is removed by the intracapsular technique, as described above.

POSTOPERATIVE PERIOD

The third stage of the operative complex begins as soon as the patient has been carefully placed in a previously prepared, comfortable bed in which he will have to lie more or less still or at the very least quiet for 24 or 48 hours.

The patient must be ensured complete rest. The methods which we use for this purpose have already been discussed in the section on preoperative management (we would only remind that prolonged sleep is advisable).

The first dressings are changed 24 to 48 hours after the operation, depending upon the condition of the eyes. In the presence of special indications (a not wholly satisfactory condition of the conjunctival sac or lacrimal drainage system revealed before the operation, increased intraocular pressure, pain in the eye operated on, a soaked bandage, restlessness in the patient, etc.) dressings must be changed 24 hours after the operation. It should be remembered that bacterial infection can develop already within this period. The bandage may usually be removed from the second eye during the first change of dressings. We change the second dressings in the ward, and subsequent ones in the dressing-room.

A more or less strict bed regimen is recommended only in the presence of special indications: poor apposition of the wound edges, non-restoration of the anterior chamber, severe postoperative eye reaction, prolapse of the vitreous or the iris, and others. It should be taken into account that little carefully supervised movement facilitates metabolism, the resorption of the products of inflammation, blood, lenticular remains, etc. The patient feels better after it, he is put in a good mood, his hopes of quick recovery are strengthened, etc.

We attach much importance to the condition of the pupil both during the operation and after it. A subconjunctival adrenalin injection keeps it dilated only for about five hours. For that reason, the principal concern of the surgeon who has just completed a cataract extraction is to apply active

measures to dilate the pupil, ensure rest for the iris and prevent the formation of adhesions between the pupillary borders and the internal coats of the eye or the vitreous. An increase of intraocular pressure does not contraindicate the use of mydriatics. On the contrary, it is a direct indication in some instances: in the presence of synechiae and adhesions, obstruction of the pupillary aperture by the vitreous, a narrow pupil, etc., which increase pressure, dilation of the pupil reduces intraocular pressure.

We adhere to the rule that the pupil should be dilated persistently; but considering that the eye should be disturbed as little as possible during the first postoperative days, we change dressings not more than once a day unless there are special indications, and introduce a 1 per cent atropine solution into the conjunctival sac each time. From the third or fourth day we instill atropine (or scopolamine) more frequently and there is no reason to refrain from changing dressings as often as required for this. The bandage may be removed as early as on the sixth or seventh day in individual cases that have taken a very sedate course.

If adequate pupillary dilation cannot be achieved in this way, subconjunctival injections of adrenalin (per 0.1 millilitre) should be made, and repeated when necessary, or cotton soaked in a cocaine or adrenalin solution should be placed under the lower lid as already described. The most potent mydriatic effect is obtained by dry atropine (in substantia), through introducing one or two grains into the conjunctival sac. This is an old, but extremely effective, measure whose value has been demonstrated in practice. True, there is a prejudice against it based on the fear of poisoning the patient, but there are no real grounds for this. Certain precautions, however, must be taken to prevent atropine dissolved in lacrimal fluid from entering the nasal and oral cavities. The following well-known method is recommended: while atropine is introduced into the sac, the skin at the inner angle of the eye above the lacrimal duct is pressed with a finger for several minutes, and the patient is kept under observation for two or three hours. Upon the appearance of any signs of atropine poisoning (restlessness, involuntary movements of the extremities, convulsive yawning, dryness of the mouth, etc.), one millilitre of a 10 or 20 per

cent caffeine solution is injected subcutaneously, or the patient is given a cup of strong coffee. If that proves insufficient, one or two millilitres of a 1 per cent morphine solution (antidote against atropine) are introduced subcutaneously. We have never ignored this method of pupillary dilation during our years of practice, using it whenever needed (in the absence of contraindications, of course), and have encountered no unfavourable after-effects.

Atropine has the advantage that it stimulates the dilator while paralysing the pupillary sphincter. Some patients are hyper-sensitive to atropine; they should be treated with a 0.2-0.3 per cent solution of scopolamine instead.

With adequate preoperative management, a well-performed operation, and proper postoperative care, the operative period should normally take a smooth and non-protracted course.

CHAPTER 7

COMPLICATIONS

Whatever the method used to extract a cataract, the operation can give rise under all conditions, mild or severe, to a number of complications, which may influence its outcome to some extent.

The complications may occur during the operation or in the postoperative period. Postoperative complications may in turn be early or late.

COMPLICATIONS DURING THE OPERATION

It is a matter of satisfaction that comparison of data supplied by earlier authors with those published more recently shows that great advances have been made in surgical treatment of cataract both as regards operative procedure as such and as regards the therapeutic and preventive control of complications. Infection, expulsive haemorrhage, and other conditions, for instance, are seldom encountered now.

The complications that can occur during extraction are discussed in what follows.

During a retrobulbar injection and acinesia of the eyelids the tip of the needle may pierce the wall of a blood vessel and cause a *retrobulbar haematoma*; the eyeball becomes immobile and protrudes, while the eyelids become swollen and numb. To avoid this, one must make sure, by slightly drawing out the plunger that the needle has not injured a vessel; if the vessels are intact, no blood will enter the syringe and the solution may be injected. Otherwise, the needle should be withdrawn and pressure applied to the lids for several minutes. If no haematoma forms within that time the operation may be started; but if haematoma does develop, measures should be taken to prevent negative con-

sequences like those encountered in the case described below. These measures comprise the following. An incision 1.5 to 2.0 centimetres long should be made at once in the upper eyelid parallel to its margin immediately below the superior orbital edge (where there is no risk of injuring the m. levator palpebrae superioris), and deep enough to allow the extravasated blood to escape; the swelling of the lid will then subside. Sutures are not recommended for two reasons: firstly, blood may continue to escape through the incision; secondly, even an unsutured wound heals nicely, leaving a smooth scar. The eye is tightly bandaged after the swelling has gone down, and operation is postponed for one or two weeks.

We occasionally encountered such complications, particularly in the early period of our experience, but the condition was always managed by means of the incision described and no harmful effects were observed from it. No unfavourable after-effects of the haematoma were observed either; particularly no atrophy of the optic nerve, such as we had seen, occur in a patient when the operating surgeon for some erroneous reason refrained from making this incision.

With a thin conjunctiva that tears easily a *defect* may occur when a flap is created. It is not advisable to suture this defect immediately, but care should be taken not to make other openings. The defect should be sutured after the operation has been completed.

A mound-shaped *subconjunctival haematoma* may form if a vessel is injured while a bridle suture is being made. Pressure applied to the mound for two or three minutes with a tampon will cause the haematoma to disappear. If this does not produce the desired effect the bridle suture should be tied to arrest the bleeding (unnecessary, of course, if there is no haematoma).

Anaesthetics, particularly the currently used dicaine, can cause *erosion of the cornea*. To avoid this, the patient should be told to close his eyes, while a moistened gauze tampon is placed over the lids as soon as the anaesthetic has been instilled. Corneal erosion is no hindrance to the operative procedures themselves; but it is advisable to instill some keratoplastic substance (1:10,000 citral solution or a 1 per cent quinine solution) into the conjunctival sac at the end of the operation. We avoid the ointments recommended

by some surgeons because the substance may get between the lips of the wound, hinder their adaptation, and delay healing.

Faults may also occur when the *incision* is made. Some have already been discussed, others will be considered here. The sharp edge of the knife may be inserted between the layers of the cornea. If this is noticed in time, the knife should be withdrawn from the wound and another puncture made more accurately; but if the mistake is discovered only when the tip of the knife has entered the anterior chamber, the operation must be interrupted and postponed for several days. The tip of the knife may also be accidently thrust into the iris; it should be slightly withdrawn in that case and the iris set free; if the incision is continued a complete iridectomy will be made simultaneously and the coloboma formed will be of an unforeseen size and irregular shape.

Yet another complication may occur during the incision: one or both of the sutures previously applied may be cut. To avoid this the suture loop should be made sufficiently long to create no difficulties when it is shortened, should the thread be cut; its corneal end is pulled (shortening the loop), threaded on a needle, and the suture replaced.

The *iris* may *prolapse* and become *incarcerated* in the incision when the latter has been completed. Every possible measure should be employed to replace it without exerting force, as described on page 107. Pressure on the eyeball must be avoided to prevent iris prolapse, especially if the iris is rigid, since that condition predisposes to a prolapse and makes replacement difficult.

Complications may also be encountered during procedures conducted on the *lens*. It should be remembered that the capsule may rupture during an attempted intracapsular extraction, transforming the operation into an extracapsular procedure. This should be considered a failure. The greater the number of ruptures the less chance there is of a + or even of a ± result. On the other hand, in a planned extracapsular extraction an opening made so small that it causes difficulties in delivery of the nucleus is a setback, though remediable. The opening has to be enlarged with a cystitome or capsule forceps if the nucleus cannot be delivered by the appropriate manipulations.

sequences like those encountered in the case described below. These measures comprise the following. An incision 1.5 to 2.0 centimetres long should be made at once in the upper eyelid parallel to its margin immediately below the superior orbital edge (where there is no risk of injuring the m. levator palpebrae superioris), and deep enough to allow the extravasated blood to escape; the swelling of the lid will then subside. Sutures are not recommended for two reasons: firstly, blood may continue to escape through the incision; secondly, even an unsutured wound heals nicely, leaving a smooth scar. The eye is tightly bandaged after the swelling has gone down, and operation is postponed for one or two weeks.

We occasionally encountered such complications, particularly in the early period of our experience, but the condition was always managed by means of the incision described and no harmful effects were observed from it. No unfavourable after-effects of the haematoma were observed either; particularly no atrophy of the optic nerve, such as we had seen, occur in a patient when the operating surgeon for some erroneous reason refrained from making this incision.

With a thin conjunctiva that tears easily a *defect* may occur when a flap is created. It is not advisable to suture this defect immediately, but care should be taken not to make other openings. The defect should be sutured after the operation has been completed.

A mound-shaped *subconjunctival haematoma* may form if a vessel is injured while a bridle suture is being made. Pressure applied to the mound for two or three minutes with a tampon will cause the haematoma to disappear. If this does not produce the desired effect the bridle suture should be tied to arrest the bleeding (unnecessary, of course, if there is no haematoma).

Anaesthetics, particularly the currently used dicaine, can cause *erosion of the cornea*. To avoid this, the patient should be told to close his eyes, while a moistened gauze tampon is placed over the lids as soon as the anaesthetic has been instilled. Corneal erosion is no hindrance to the operative procedures themselves; but it is advisable to instill some keratoplastic substance (1:10,000 citral solution or a 1 per cent quinine solution) into the conjunctival sac at the end of the operation. We avoid the ointments recommended

by some surgeons because the substance may get between the lips of the wound, hinder their adaptation, and delay healing.

Faults may also occur when the *incision* is made. Some have already been discussed, others will be considered here. The sharp edge of the knife may be inserted between the layers of the cornea. If this is noticed in time, the knife should be withdrawn from the wound and another puncture made more accurately; but if the mistake is discovered only when the tip of the knife has entered the anterior chamber, the operation must be interrupted and postponed for several days. The tip of the knife may also be accidently thrust into the iris; it should be slightly withdrawn in that case and the iris set free; if the incision is continued a complete iridectomy will be made simultaneously and the coloboma formed will be of an unforeseen size and irregular shape.

Yet another complication may occur during the incision: one or both of the sutures previously applied may be cut. To avoid this the suture loop should be made sufficiently long to create no difficulties when it is shortened, should the thread be cut; its corneal end is pulled (shortening the loop), threaded on a needle, and the suture replaced.

The *iris* may *prolapse* and become *incarcerated* in the incision when the latter has been completed. Every possible measure should be employed to replace it without exerting force, as described on page 107. Pressure on the eyeball must be avoided to prevent iris prolapse, especially if the iris is rigid, since that condition predisposes to a prolapse and makes replacement difficult.

Complications may also be encountered during procedures conducted on the *lens*. It should be remembered that the capsule may rupture during an attempted intracapsular extraction, transforming the operation into an extracapsular procedure. This should be considered a failure. The greater the number of ruptures the less chance there is of a + or even of a ± result. On the other hand, in a planned extracapsular extraction an opening made so small that it causes difficulties in delivery of the nucleus is a setback, though remediable. The opening has to be enlarged with a cystitome or capsule forceps if the nucleus cannot be delivered by the appropriate manipulations.

These manipulations have to be made with great precaution since they can be responsible for disagreeable after-effects associated with *dislocation of the lens.* The upper edge of the latter may move under the sclera when the capsule is grasped with the forceps and the erysiphake cup is pressed to it without due care. Dislocation shows as a black band appearing in the lower segment of the pupil. Pressure on the cornea should not then be continued because it may cause dislocation of the lens into the vitreous. Attempts should be made to return the lens to its place by carefully stroking the cornea with downward movements. If this proves ineffective, one should try to put the lens in place with the tip of a cystitome introduced into the anterior chamber. Either way, the operative approach has to be changed: it is best to extract the lens with Weber's loop as follows (Fig. 18) (it goes very well if the anterior

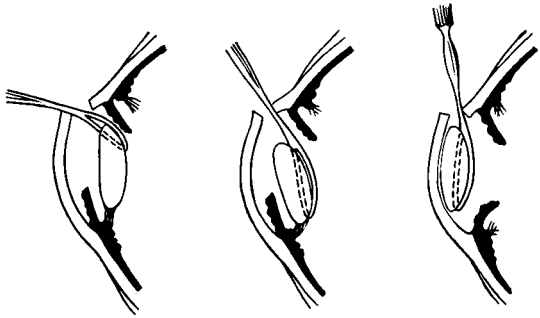


Fig. 18 Extraction of the lens with a loop

concave surface has teeth). The loop is introduced into the incision at an angle of 45 degrees, then its handle is raised (away from the operator) and the instrument is brought quickly around the upper edge of the lens, advanced slightly deeper, and the handle is drawn downwards (toward the operator) quickly so that the lens settles in the loop. Then the lens is pressed against the posterior corneal surface and withdrawn together with the loop. The vitreous membrane is ruptured during this procedure, of course; the extent of the damage depends upon the accuracy of the

surgeon's movements and his caution. Vitreous loss is assumed to be inevitable, but our experience is to the contrary. We have employed the loop many times when indicated for various reasons and often no vitreous loss was encountered.

Complete dislocation of the lens in the vitreous is quite rare fortunately and is due mainly to the latter being fluid. This grave complication cannot only be fatal to the eye functions, but it may also lead to such severe traumatic irritation that the eye has to be enucleated for fear of sympathetic inflammation. Secondary glaucoma is another severe after-effect.

It is therefore mandatory that every effort should be made to deliver the lens from the vitreous (which is very difficult). A moistened gauze or cotton is placed over the eye for 15 or 20 minutes. If the lens returns to its place as it sometimes does, an attempt should then be made to extract it with a loop. A stream of fluid from a syringe or an irrigator can be directed immediately on the surface of the vitreous to vibrate it and force the lens to float to the surface.

Where these procedures prove ineffective, the task of "rescuing" the lens from the vitreous arises, which is, we repeat, an extremely difficult task. There is no need to hurry with these measures, however, because the lens may frequently come to the surface of its own accord within several hours or days and then be removed. An experienced surgeon should not be barred from attempting to remove the lens; but it is very difficult to do this blindly and there is a danger of damaging the vitreous and causing its loss. Therefore every effort should be made to locate the lens, the patient sometimes being turned from side to side, or even placed in a sitting position and the operation made in the most suitable posture. The wound edges should be approximated by pulling on the sutures to prevent vitreous loss, and then the lens searched for. We have little experience of the procedure here described, but we have conducted it successfully, in a few cases when we had to remove the lens from the vitreous, by the technique suggested by G. Rabinovich. With the patient placed in the most advantageous posture, we pierced the sclera with a discis-

sion needle and after advancing it beyond the lens under ophthalmoscopic control used it to push the lens closer to the pupil, where it is reached relatively easily with a loop.

The lens can also be rescued from the vitreous by introducing a diathermy needle into the eyeball. As soon as it touches the capsule, the current is switched on; through its effect coagulation occurs and the needle is easily withdrawn with the lens "sticking" to it. But the best method, which guarantees successful removal of a partially or completely dislocated lens or even of a lens submerged in the vitreous, is cryoextraction.

Vitreous prolapse and vitreous loss. Injury to the vitreous causes loss of both fluid and formed vitreous into the anterior chamber and its prolapse or escape through the incision in the outer coats of the eyeball. This loss understandable when the pressure exerted on the vitreous by these coats is considered.

Owing to the mutual connections between the molecules of a formed vitreous, its prolapse may quite easily cease either spontaneously or as a result of measures taken by the surgeon; but loss of fluid vitreous is arrested with difficulty. Most ophthalmologists are unanimous about the significance of vitreous loss. The danger arising from it depends upon the properties and quantity of the tissue lost. The closer its consistency to normal, the greater the danger, other conditions being equal; loss of fluid vitreous is a relatively small danger, being not so much a menace as an inconvenience that hampers further manipulations by the surgeon. A small prolapse of formed vitreous is also not very dangerous, but a large loss can have the following consequences: development of infection, retraction of the cornea, collapse of the eyeball, uneven cicatrization of the wound resulting in postoperative high astigmatism, the appearance of permanent opacities in the vitreous, intraocular haemorrhages, secondary retinal detachment, etc. It may be said that about 6 per cent of eyes which have suffered some degree of vitreous loss become blind if proper measures are not applied to restore the loss.

Dunphy (1928) made a follow-up of fifty patients in whom cataract extraction was attended with large vitreous loss

and found that the eye operated on became blind in six and showed a visual acuity below 0.4 in the remainder.

Vitreous loss used to be quite a frequent occurrence, during cataract extraction, particularly in intracapsular one, mainly during operations on protruberant eyes closely covered by the eyelids, on eyes that had suffered disease or injury, and, of course, when the surgeon or his assistants made errors in the technique.

The best way to avoid vitreous loss or, at least to reduce it to minimum, is to employ the correct operative technique and to perform all procedures immaculately. In our discussion of oxygen insufflation it was mentioned that the introduction of the gas into the anterior chamber contributed to the purpose. This has something in common with the suggestion made by Awasthi and Raizada (1965) that 0.2 cubic centimetre of sterile air be introduced into the anterior chamber and an equal volume of aqueous humour withdrawn from it, before the eye section is made. According to the authors, this manipulation reduced the incidence of vitreous loss from 6 to 0.5 per cent.

Of obvious importance for preventing vitreous prolapse are quiet behaviour of an adequately prepared patient (administration of tranquillizers and hypertonic solutions), prescription of alpha-chymotrypsin, and strict adherence to the rules and technique described above. Introduction of oxygen into the eyeball, abundant fluid intake, general and local administration of vitamins, particularly vitamins C and PP, etc., are recommended as therapeutic measures.

Protrusion of the vitreous into the anterior chamber, so-called *vitreous hernia*, is a condition much less hazardous than vitreous prolapse or loss, but its significance should not be underestimated, as it can give rise to keratitis striae, secondary glaucoma, and other complications. A hernia may form owing to the pressure exerted on the vitreous from all sides by the dense coats of the eyeball, which cause it to find an exit to the front along the line of least resistance resulting from the removal of the lens which had previously held it back. A hernia may form with an intact vitreous membrane; this is known as simple hernia to distinguish it from the complicated hernia that occurs when the membrane is ruptured.

We encountered this complication in 26 per cent of intracapsular extractions with forceps of a primary cataract.

Prolapse or loss of vitreous can occur at any stage of the operation; its significance for the fate of the eye varies with the stage.

A formed vitreous can prolapse either while the section is being made or at the end of it with complicated cataract, with partial or complete dislocation of the lens, or through undue pressure on the eyeball. The prolapse may occur when the patient coughs or holds his breath, since both conditions cause strain, and not infrequently without apparent cause. The appearance of vitreous in the incision is not always followed by its prolapse; having appeared, it may withdraw; if that does not occur, it should be carefully replaced, preferably by means of a fairly strong stream of oxygen or physiological saline solution aimed directly on the prolapsing part. Should that procedure be ineffective, then the vitreous should be replaced with a spatula, with maximum precautions to avoid rupture of its membrane. It is advisable to cover the closed lids with a tampon abundantly soaked in physiological saline solution at room temperature; this alone may cause the vitreous to withdraw even before any of the manipulations described above is resorted to, or may contribute to that effect. The tampon can be removed in three to five minutes and oxygen introduced into the anterior chamber.

Further manipulations need to be made with the utmost precaution whether by the method commonly employed or by means of the loop. It should be remembered that application of a loop causes severe trauma to the vitreous.

Vitreous prolapse occurring after removal of the lens is a less grave condition since the principal stage of the operation has already been completed.

The procedures described here for replacement of vitreous and prevention of further prolapse enable the operation to be followed through to the end, and a peripheral iridectomy even to be made.

As already said, loss of fluid vitreous is of less importance than the prolapse of a formed one because the former is quite rapidly restored by the secretion-diffusion process taking place in the ciliary body; while that is taking

place, the empty space left in the eyeball is filled with oxygen.

Expulsive haemorrhage is perhaps the gravest operative complication of cataract extraction, and has severe after-effects. Fortunately, it is very rarely encountered.

A few cases of this complication occurred in the early period of our surgical practice, which seemed fatal and unmanageable. The tragedy of the condition is that, being caused by systemic factors (cardio-vascular disorders mainly) it can, as a rule, also occur during an operation performed on the second eye.

In later years we did not encounter this complication in our practice which may be partly accounted for by pathogenetic preventive measures: namely, reduction of arterial pressure by various means, even by bloodletting immediately before the operation; regulation of sugar metabolism in diabetics; reduction of rest nitrogen to the minimum in patients with nephritis, etc., as well as regular administration of vitamin K (vicasol given in doses of 0.01-0.02) for two or three days before the operation and in the immediate postoperative days. Insufflation of the eye with air and later with oxygen also played an important, and perhaps even the principal, role.

Local measures to cause as little pressure on the eyeball as possible are very important in preventing expulsive haemorrhage; they include avoidance of eye speculum and lid retractor, use of a bridle suture, acinesia, retrobulbar anaesthesia, etc.

Filatov proposed a posterior scleral trephination in conditions liable to expulsive haemorrhage (increased arterial pressure, glaucoma, where one eye had been destroyed by haemorrhage, etc.). Auerbach and his clinic have made wide use of this method.

Expulsive haemorrhage can occur at any stage of the operation, but it is mostly encountered in the postoperative period. Blood seemingly escapes either from one of the short or long ciliary arteries, or from the central retinal artery, and invades the subchoroidal space. There it detaches the choroid and retina and pushes them out of the eyeball through the gaping wound together with the vit-

reous and the lens (if the haemorrhage occurs before the latter has been removed).

Then it seeps through the wound. This is attended by severe pain in the eye and headache, and sometimes by nausea, vomiting, and excessive perspiration.

The therapeutic measures to be applied when the expulsive haemorrhage has already occurred cannot be considered very effective. Ferhoeff (1915) suggested a posterior sclerotomy, Filatov (1933) recommended trephination of the sclera at the site of the posterior long ciliary arteries.

COMPLICATIONS IN THE POSTOPERATIVE PERIOD

The postoperative period does not always follow the smooth course described earlier, and is not infrequently complicated by a number mild or severe sequelae arising early or late that influence the results of the operation in one way or another depending on their character.

Keratitis striata. The name does not correspond to the essence of the process, which is an optical phenomenon with no elements of inflammation. It consists in the formation of folds, mainly vertical, in Descemet's membrane; owing to the fact that the folds are arranged at an angle to the rays of light falling on them they reflect rather than transmit the latter so that they are seen as striate opacities by the examiner. Vision in the eye operated on becomes impaired. The impairment, however, is reversible in most cases, since the folds formed by bruising of the cornea soon smooth out even without treatment, and the cornea regains its former transparency. The complication is avoided by delicate performance of the operation. A certain role in the formation of folds is undoubtedly played by the vitreous coming in touch with the corneal endothelium.

Corneal dystrophy and bullous keratopathy due to trophical disorders are much graver complications. They are showh in small bullae appearing at the site of the incision, and are the result of metabolic disturbances which may be due to various causes: the incision itself violating the intactness of the tissues, the vitreous coming in contact with the corneal endothelium, etc. The presence of degenerative

processes before the operation (cribriform opacities, endothelial dystrophy, etc.) contributes particularly to the appearance and development of corneal dystrophy. The process requires vigorous treatment in the form of instillations of 1:10,000 citral solution, cod-liver oil, or vitamins (B_2 or C in a 5 per cent glucose solution) into the conjunctival sac. In some intractable cases the eye becomes blind and the pains so severe that enucleation has to be resorted to. The condition described is a late complication and is not usually encountered earlier than two weeks after the operation.

Many years ago we witnessed a complication which presented a terrible picture, but nonetheless terminated favourably. During the first change of dressings the upper half of the opaque cornea was found to be folded forward at an angle of 90 degrees and pressed between the edges of the eyelids. Fortunately, the quantity of cortical remains in the eyeball was quite large, and so its contents did not escape. The patient was taken to the operating room where the cornea was replaced and the wound covered with a conjunctival flap. Everything turned out satisfactorily although there were at that time no antibiotics, sulphonamides, oxygen therapy, corticosteroids, etc. Severe and protracted striate keratitis was the only after-effect of this seemingly extremely rare complication. Corneal transparency was not completely restored, but the visual acuity was quite fair.

Failure of the anterior chamber to re-form or its delayed re-formation. Several conditions may be the cause of this complication, delayed healing of the wound due to individual features of the patient being the primary one. The lips of the wound do not adhere along its entire length in these cases. A second cause is of a local character and is more frequently encountered; it consists in incarceration of scraps of the capsule, lenticular fibres, vitreous fibrils, and the iris in the wound. We then find that almost the entire wound has closed with the exception of the part around the incarcerated tissue, where a sort of a fistula forms. The following phenomenon is sometimes observed: the anterior chamber which had re-formed to its normal depth suddenly flattens out on the fifth or sixth postoperative day, becoming shallow or even collapsing, while the

wound remains closed and no fistula is revealed. In these cases it may be presumed that detachment of the choroid has occurred owing to a drastic decrease in the intraocular pressure.

The next complication, or group of complications to be more precise, *incarceration of membranous strands and vitreous fibrils* in the wound, may be discussed together with prolapse of the iris. The conditions are associated with delay or failure in re-formation of the anterior chamber.

Any tissue projecting from the wound has to be removed. Two approaches may be used for this simple manipulation: (1) without opening the anterior chamber, and (2) by opening it. With the first method the thin strands of the membrane and vitreous can simply be cut off; their elements remaining in the chamber will later undergo resorption, while those incarcerated in the wound itself are so thin that they play no particular role. Incarceration of thick strands of tissue, or of the iris, requires different surgical management. It is not advisable to avoid opening the chamber because at best avoidance will give only a cosmetic effect: the wound will appear smooth though its condition will actually not have changed. In these cases, and in prolapse of tissues and of the iris, the patient should be operated on immediately the condition is recognized and before the wound has consolidated; the anterior chamber should be opened and the tissues incarcerated in the wound pulled out and cut off with fine scissors or forceps-scissors, pressing the instruments slightly against the eyeball; then the iris should be carefully replaced. It is advisable to cover the fresh wound with a conjunctival flap previously created by a variant of Kuhnt's method, well-known to any ophthalmologist. The technique prevents the occurrence of any unfavourable after-effects of this complication. In no case should the incarcerated tissues be cauterized, because this procedure, whether done chemically or thermally, causes greater and deeper trauma to the tissues than that produced by the manipulations described. The early literature even carries information on the possibility of sympathetic inflammation following electrocoagulation of a prolapsed iris.

Several drops of a miotic should be instilled into the

eye after the operative procedures have been completed, both eyes bandaged, and the patient prescribed bed rest for two or three days. The prophylactic therapeutic measures described in previous sections should be applied to avoid development of infection.

It will be recalled that the chamber should re-form within five or six hours; although there is no hazard if this does not occur, proper measures should nonetheless be applied. With the removal of such causes as incarceration of tissues in the incision, the condition is quickly relieved.

That is not so, however, when changes in the condition of aqueous humour production are responsible for failure of the chamber to re-form. As has already been said, this complication may result either from hypersecretion or hyposecretion. It is not always easy to determine which of these factors is responsible in a given case. With subatrophy or atrophy of the eyeball it is not difficult, of course, since there we have to deal with hyposecretion of aqueous humour; consequently it is necessary to stimulate its production to get a more rapid re-formation of the chamber. Hypersecretion, on the contrary, may be supposed where there is an increase in intraocular pressure, and needs to be obviated. Both conditions can be managed by the appropriate measures; but since it is sometimes difficult to recognize which of them is present patients are prescribed vitamin C, which increases aqueous production, and drugs, like diamox, diacarb and phonurite, that exert an opposite effect by suppressing secretion. Their use does not always serve the purpose, their effect sometimes being adverse. According to some authors, re-formation of the chamber occurs as early as the first day, with diamox administered (on the day of the operation and for two days after) in capsules that dissolve slowly in the gastrointestinal tract, while without the drug re-formation takes place much later in 7 or 8 per cent of cases. It is also presumed that diamox reduces the incidence of iris prolapse following cataract extraction from 13 to 5 per cent, and of vitreous prolapse by 50 per cent. Other authors do not consider diamox valuable. The different evaluations of its effect would seem to be explained by the fact that it was used without due regard to the regimen of aqueous secretion.

In our opinion, the most effective method to prevent delayed re-formation is insufflation of the anterior chamber with oxygen. As an additional measure we administer (where it is possible to determine the regimen of aqueous production) either vitamins C and PP or diamox, as the case may require, and under all conditions pilocarpine, which regulates the flow of aqueous humour and facilitates normal filling of the chamber.

Giardini (1956) recommends treating failure of the chamber to re-form by diathermocoagulation of the incision, application of plasmothrombin to the wound, and introduction of air into the anterior chamber. Chandler (1954) also employs the last-named procedure.

Epithelial downgrowth. Invasion of the anterior chamber by corneal or conjunctival epithelium is a malignant complication frequently attended by the formation of cysts. Two factors facilitate this process, which is easier to prevent than to cure. One is a potentially constant in action—the marked capacity of the epithelium to proliferate and regenerate when stimulated by trauma. The other occurs in individual cases and consists in incomplete closure of the wound due to poor approximation of its edges (technical faults, incarceration of the capsule or iris, or of vitreous fibrils in the wound, etc.). The incarcerated tissue serves as a channel along which the epithelium grows into the anterior chamber.

The epithelium covers the posterior corneal surface only when the latter suffers dystrophy, and does not extend over normal endothelium. Most frequently it covers the remains of the lens capsule. The complication is indicated by a haze on the posterior surface of the cornea and by an opalescent membrane beginning at the wound. The fact that it is not always easily recognized, suggests that regular biomicroscopical examination of the eye operated on is advisable. It has been noted that most cysts are revealed only on histological examination of the enucleated eye.

Irradiation by X-rays or radium, aspiration of the cysts following the introduction of a 3 per cent iodine solution, a 50 per cent glucose solution, a 10 per cent solution of trichloracetic or of pure carbolic acid into the anterior chamber, as well as surgical removal, should be considered

the best methods of treatment. A progressive process can give rise to uveitis attended by increased intraocular pressure.

Haemorrhage in the anterior chamber (*hyphaema*) is a frequent though not very grave complication. It is usually encountered between the fourth and seventh postoperative days, which should be borne in mind during the postoperative management. Hyphaema disappears as a rule within several days, but recurrent attacks are observed in rare cases; these patients are prescribed partial bed rest.

The ophthalmologist attending such cases should (a) apply measures to prevent recurrences (adequate preoperative management is very important, of course, as in the prevention of haemorrhages in general), and (b) evacuate the blood from the chamber as quickly as possible. Retention of blood can lead to haematogenic impregnation of the cornea (Rabinovich, 1931) and to the development of secondary glaucoma.

It has been suggested that phonurite prevents postoperative hyphaema and other complications, like vitreous prolapse, delayed re-formation of the anterior chamber, and detachment of the choroid.

Anticoagulants (hirudin, vitamin E, etc.), oxygen therapy, calcium chloride, rutin, and vitamin K stimulate absorption of the blood. With intractable cases, and with a chamber filled with blood, the chamber has sometimes to be opened despite the risk if the wound has not consolidated (an iris spatula is used); after evacuation of the blood the chamber should be filled with oxygen.

Blocking of the chamber angle by the iris (formation of synechiae) is a late complication of cataract extraction not frequently encountered. It can sometimes be so severe that an iridectomy may be required. For that reason, it is best to avoid it by performing a peripheral iridectomy or iridotomy in good time as a stage of the original operation.

Blocking of the pupil usually occurs following an extracapsular extraction, but may also be encountered after an intracapsular procedure. Its cause and the mechanism of its appearance differ with the operative method. With an extracapsular technique it takes the form of extension of the pupillary margin to the lenticular remains with adhe-

sion, adhesion of the iris to the vitreous, etc. With the intracapsular method blocking may be caused by incarceration of a vitreous hernia or gas (air, oxygen) in the pupil. The blocking interferes with the flow of aqueous from the posterior to the anterior chamber: the outflow exceeds the inflow, the chamber angle becomes narrower, aqueous drainage becomes difficult, and the intraocular pressure may increase (vide "Secondary Glaucoma"). Other cases may be marked by a posterior detachment of the vitreous, which moves forward, and begins a peculiar vicious circle. A peripheral iridectomy or an iridotomy and an adequately vigorous instillation of mydriatics are recommended as preventives, while the condition itself is treated with mydriatics, and incision of the vitreous if necessary.

Detachment of the choroid. A classic detachment of the choroid occurs two or three weeks after the operation, but may also be encountered immediately after it. It is the most frequent cause of extreme shallowness or collapse of the anterior chamber. Changes in size of the chamber are attended by a sharp decrease in visual acuity and a reduction of intraocular pressure to ten millimetres of mercury and even lower. In the ophthalmoscope, detachment of the choroid resembles a melanoma rather than a retinal detachment. It is spherical in shape and covered by blood vessels, and is usually located in front of the equator. The complication occurs (most frequently with intracapsular extraction) owing to the contents of the eyeball moving forward away from the rigid sclera; the space formed between the sclera and the choroid fills with fluid from the vessels. Treatment consists in complete bed rest. Choroidal re-attachment normally takes place without special measures and complete recovery follows in two or three weeks. It should be borne in mind that if detachment has occurred in one eye, the same complication can also be expected after an operation on the other eye.

Recovery, however, does not always follow a favour ble course. If the choroid has not become re-attached after two or three weeks, surgery has to be considered. A conjunctival flap is created at the site of greatest detachment and folded aside and the sclera is punctured with a diathermy needle; the subchoroidal fluid escapes through this

puncture wound after which the choroid returns to its place. To consolidate the result oxygen may be introduced into the anterior chamber through a beveled (valve) opening made with an injection needle or with a trephine. A patient with choroidal detachment has to be kept under punctilious daily observation: if the process becomes protracted and shows no signs of regression, a circular anterior synechia may form giving rise to severe, if not to say incurable, secondary glaucoma.

Secondary glaucoma may be caused by other conditions than those described above. Increase in intraocular pressure may result from almost any of the complications discussed, such as ingrowth of tissue strands or the edges of the conjunctival flap into the wound, epithelial downgrowth, particularly into the chamber angle, the formation of cysts in the angle, and occlusion of a constricted pupil by an advanced vitreous. The condition is particularly hazardous with eyes in which the glaucomatous process had occurred before the operation for cataract. The therapeutic measures depend upon the cause of the complication. Unfortunately it may not always be recognized, and even when revealed cannot always be removed.

Hypotonia of the eyeball signals the presence of deep trophical disturbances, but is a much lesser evil than glaucoma. It may be due to mechanical factors: aqueous leakage through a gap formed somehow in the wound, choroidal detachment, disturbance of the secretory-diffusion function of the ciliary body, or anterior uveitis.

A mild hypotonia is no great danger, but if it persists for any time and intraocular pressure falls sharply vigorous measures must be taken to raise it. They should aim at producing hyperaemia of the ciliary body and improving the metabolism of the eye, which may be achieved with atropine and dionine (the latter being administered in concentrations gradually increased from 2 to 10 per cent), a warm 1 per cent quinine solution in the form of instillations, subconjunctival or retrobulbar injections, or electrophoresis, and subconjunctival injections of sodium chloride. A good effect is produced by paraffin applications, oxygen therapy, heat, osmotherapy, large doses of ascorbic acid given in combination with nicotinic acid

which stimulate the secretion of aqueous humour, and by corticosteroids.

Dissection of all four rectus muscles is the last resort to increase intraocular pressure; our experience has convinced us of its efficacy.

Obviously, if there is a leak in the wound the latter has to be examined as previously described.

Detachment of the retina is a late and rare complication of cataract extraction. The predisposing factor is myopia, while the causative factor may be vitreous loss or forcible pulling on the zonular fibres. The prospects for repair are especially poor with vitreous loss because degenerative changes in the form of bands may occur in the vitreous body and pull the retina away from the choroid. The only treatment is surgical, the method of choice being one of the operations for scleral shortening.

Macular degeneration is a peculiar and extremely rare and late complication which it is perhaps more correct to consider a pathological process stimulated by absence of the lens. Small changes are seen in the yellow spot, displayed either by an absence of the foveal reflex or a general haziness of the entire region. There is no complete proof of a causal relationship between aphakia and macular degeneration.

Anterior uveitis. A reaction of various intensity occurs in any tissue sustaining a trauma. The reaction produced in the eyeball is displayed by a classic picture of iritis or iridocyclitis (anterior uveitis).

To explain the origin of the reaction we must dwell on the essence of the changes that take place in the tissue as a result of the trauma. The character and degree of the reaction depend upon a number of factors and conditions, which may be divided into two groups: one embraces the features of the trauma itself and the conditions under which it was sustained, while the other includes the background against which the reaction develops. The outcome of the reaction depends on the direction and strength of the resultant of the interaction of these two sets of factors. The reaction arising from an operative trauma sustained under maximally favourable conditions, that is, from an operation performed by an experienced surgeon on an adequately

prepared patient under aseptic conditions and employing proper instruments, is negligible as experience shows. It may be called a traumatic irritation. This inevitable and natural reaction lasts for a considerable time, depending on its intensity, and subsides without affecting the eye functions, leaving only slight traces which vary with each case.

The eye does not always respond so lightly to operative trauma, however. Under certain conditions the reaction is much more severe. The presence or absence of factors responsible for the rise and development of a severe postoperative reaction depends to a certain extent on the surgeon's skill. Without discussing this in detail, we may mention the following moments that can give rise to unfavourable consequences: a short section that limits the surgeon's manipulations, as a result of which the tissues are crumpled; a section made at the wrong site; insufficiently sharp instruments which crumple and lacerate the tissues instead of dissecting them; inadequate handling of the tissues (pulling on the iris, grasping it roughly with the forceps, careless replacement of the iris); haemorrhage into the eyeball; vitreous prolapse, etc. A definite role is also played by complications that develop in the postoperative period: prolapse of the iris, haemorrhage in the eyeball, etc.

A. *The first group. Phacogenetic endophthalmitis* is of particular importance. It is caused by the presence of lenticular remnants not removed from the eye for some reason (an extracapsular or an unsuccessful intracapsular extraction), which exert a toxic effect on the tissues and give rise to endophthalmitis (Rabinovich, 1931, and others).

Three types of factor may give rise to this process: mechanical, chemical, or anaphylactic. The lens, and particularly the nucleus, has marked organ specificity. The anaphylactic theory is most convincing and is confirmed both by clinical data and experimental findings. Endophthalmitis differs from the infectious processes described later in the character of the precipitates, which are shapeless, loose, and light-blue in colour; they are evidently elements of the lenticular tissue and readily undergo resorption. The reaction usually occurs at the site of the remnants. The involvement of the other coats in the proc-

ess is relatively slight. Lymphocytes prevail in the exudate. These properties distinguish phacoanaphylactic endophthalmitis from an infectious process, which is marked by the prevalence of polymorphonuclear cells in the exudate and involvement of the other eye coats.

The treatment is usually quite effective and consists above all in intensive dilation of the pupil, with oxygen therapy, instillations of cortisone and of a 2 per cent amidopyrine solution together with adrenalin, intravenous injections of a 40 per cent glucose solution and urotropin (methenamine), autohaemotherapy, administration of antibiotics, cortisone or its analogues given per os, and desensitization with lens protein (Rabinovich, 1931).

Some intractable cases do not respond to this treatment and can be managed only by a section of the anterior chamber with removal of all possible lenticular remains and introduction of oxygen, for both its mechanical and, especially, its biochemical effect.

B. *The second group* of factors capable of producing marked postoperative inflammation of the uveal tract includes the background against which the reaction develops, the degree of body reactivity to the trauma, and the somatic and neuro-psychic condition of the patient (chroniosepsis, various infections, local inflammatory processes and foci existing prior to the eye disease, etc.).

The intensity of the inflammation varies from case to case, and the outcome varies correspondingly from complete recovery to functional and anatomical death of the eye.

Postoperative infection is one of the severe postoperative complications. Two types are distinguished: (a) exogenic, signs of which may be detected as early as the second postoperative day; and (b) endogenic, which begins between the seventh and ninth day. It is to the credit of the profession that the incidence of postoperative infection and of other complications is becoming more and more rare, and we have every right to expect that this complication will in time be forgotten. This is confirmed and illustrated by the data presented below. This undoubted advance may be ascribed to adequate preoperative management and to measures that permit operations to be performed with minimum risk.

Infection following cataract extraction is now so rare that it should be classified as an "extraordinary incident". We have not observed a single case in recent years. Extensive statistical data yield similar information: postoperative bacterial infection was encountered in 22 out of 20,000 eyes, and developed most often after an extracapsular extraction. In the past pneumococcus and streptococcus were responsible for the more severe cases; now they have been replaced by *Staphylococcus aureus*, *Pseudomonas pyocyanea*, *Proteus*, and fungi. Endogenic infection is usually delayed.

The ophthalmologist, however, must be acquainted with the clinical picture of infection. An exogenic infection is marked by the presence of pus on the dressings and on the eyebrows, and oedema of the lids and conjunctiva; the wound edges are grey and infiltrated, while the cornea loses its luster and becomes cloudy. If the infection is not arrested, opacity of the aqueous humour, hypopyon, and smoothing out of the iris pattern are added to the picture. The condition often terminates in panophthalmitis.

The schematic clinical picture of an exogenic infection shows that immediate vigorous measures must be applied to arrest it; treatment is promising. The recommended measures include management without dressings, hourly irrigation of the conjunctival sac with a penicillin solution (100,000 units per ten millilitres of a 2 per cent solution of amidopyrine), instillations of antibiotics and a 10 to 20 per cent solution of albucid (sulphanil acetamide), subconjunctival injections of 0.5 millilitre of the penicillin solution described here, intramuscular injections of penicillin or some other antibiotic, and sulphonamides administered in the normal way.

Surgical intervention, paracentesis of the anterior chamber followed by irrigation with a penicillin solution, is a reserve measure.

We would draw attention to the fact that certain of the features of an infectious process developing after cataract extraction are common to many pathological processes occurring in the body: the later it appears (as regards either the age of the patient or the time elapsed after exposure

to the action of any factor), the milder its course, the better its response to treatment, and the better its outcome.

An endogenic infection bears the features of a metastatic, and usually non-purulent, uveitis. Its most common cause is some chronic (less frequently acute) inflammatory process, as tuberculosis, appendicitis, urethritis, cystitis, endometritis, or tonsillitis. Prevention consists in thorough and adequate preparation of the patient for the operation. Treatment follows the normal rules.

Sympathetic ophthalmia is an inflammatory process encountered in the form of non-purulent uveitis in the eye operated on; its peculiar feature is its transition from this eye (sympathizer) to the other (eye sympathized with) in which it may be displayed in one of two forms: (a) a less severe toxic neuritis of the optic nerve, and (b) a severe seroplastic uveitis. The nature of sympathetic ophthalmia cannot be considered wholly understood, but it would seem to have the character of an infectious process developing against the background of an allergic reaction.

The following conditions in an eye operated are a warning of danger threatening the other eye: lingering uveitis which does not respond to treatment; the presence of precipitates on the posterior surface of the cornea; tenderness of the eyeball even to a light touch, particularly in the region of the ciliary body; and hypotonia. These conditions require the closest attention, and thorough daily examination of the other eye (neuritis?!), and application of vigorous measures to combat the process in the eye operated on. Enucleation may have to be resorted to if the process becomes protracted, and if all the symptoms mentioned above become more intense, especially if there is no chance of preserving vision. Two things should be borne in mind: firstly, that it is better to enucleate several eyes that have lost their functional value and not to reveal any histological signs of sympathetic uveitis in them (that is, to obtain no proof that the enucleation had been justified), than to leave even one eye in situ that may give rise to sympathetic inflammation. Secondly, it must be considered that enucleation of the first eye will serve no purpose and may even be contraindicated if inflammation has already occurred in the second eye, because with this con-

dition visual acuity may be higher in the first eye than in the second.

Fully-justified and timely enucleation of all suspicious eyes is a prophylactic and therapeutic measure that does not rule out the application of other treatment.

To conclude our discussion of sympathetic ophthalmia, we would mention the gratifying fact that its incidence is gradually disappearing. An adequate approach to the problem of the prevention and therapy of sympathetic ophthalmia contributed to its low incidence during the last war which had factors favouring development of this condition: it occurred in 0.2 per cent of the total number of eye traumas, and in about 0.4 per cent of the penetrating eye injuries. During the Russian-Japanese war of 1904-1905 the complication occurred in 5.5 per cent (Rabinovich, 1947) of eye injuries.

It may be noted with satisfaction that an important role in the great advance made in recent years in the treatment of sympathetic ophthalmia, has been played by corticosteroids, sulphonamides, and antibiotics.

Forchheimer (1955) reports a severe case of bilateral sympathetic uveitis almost completely cured with cortisone instillations within several days. Full recovery with rehabilitation of visual function was achieved in eleven weeks.

De Rosa (1958) describes a similar case; antibiotics and sulphonamides caused subsidence of the inflammatory phenomena, while cortisone administered per os in doses of 75 milligrams over a period of ten days removed all inflammation. The vision improved to 1.0.

Nonetheless, not too much hope should be based on the possibility of successful non-surgical treatment or preventive measures. The approach has to be considered individually in each case where sympathetic inflammation may be expected, and the most effective method of prevention (while there is yet time), enucleation, should not be disregarded.

Our description of postoperative complications would be incomplete if no mention were made of *chromatopsia*, a condition not infrequently encountered following extraction of a cataract in which all objects appear to have either a blue (cyanopsia) or a red tinge (erythropsia), and less fre-

quently a yellow (xanthopsia) or a green one (chloropsia). Cyanopsia may be explained by the following phenomena: the transmission of corresponding rays through a brownish-yellow nucleus in the aged; blinding due to a relatively large pupil; or the absence of a lens blocking the passage of ultra-violet rays. Chromatopsia should be regarded only as a physiological after-effect of the operation and not as a true complication.

Finally, we must say a few words about *psychosis*, which may develop as an unfavourable occurrence in the post-operative period, in various forms: delirium tremens, hallucinations, delusion, etc. It may be caused by hypersensitivity to atropine (we know of a case of transitory psychosis that developed following the instillation of two or three drops of a 1 per cent atropine solution into the conjunctival sac). Binocular bandaging can cause unrest in emotional individuals, particularly when vision is retained in the other eye.

For these cases it is recommended to prescribe tranquillizers, introduce antidotes against atropine (morphine and caffeine) and remove the bandage from the eye not operated on.

SECONDARY CATARACT

Secondary cataract or after-cataract (cataracta secundaria) is formed from the remnants that may be encountered: (a) in most cases of spontaneous resorption of a primary cataract of any type; (b) in inadequately performed extracapsular extractions; and (c) in an unsuccessful intracapsular extraction.

The following tissue elements can contribute to the formation of a secondary cataract: (1) remnants of the lens capsule; (2) lens fibres left after the operation; (3) organized remains of pigment, blood, and plastic infiltration; (4) vitreous fibrils.

Two types of secondary cataract are distinguished—simple and complicated. The former is characterized by an absence of adhesions with the surrounding tissues. It is usually thin, semi-transparent, and involves only part of the pupil, and is relatively easy to operate on. A complicated (iritic or postiritic) secondary cataract adheres to the path-

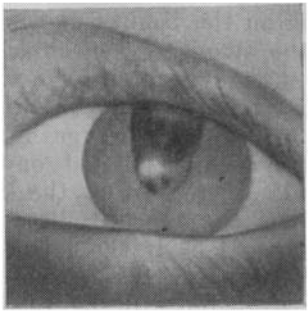


Fig. 19*a* Simple secondary cataract (personal observation)

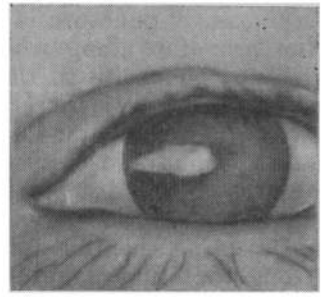


Fig. 19*b* Complicated secondary cataract (personal observation)

ological elements (adhesions, synechiae) and to the adjoining tissues. It is thick, dense, and tough, and is the product of an inflammatory process that has occurred in the anterior segment of the eye. It is difficult to operate on.

The only treatment for secondary cataract is surgical. Several therapeutic measures can stimulate the resorption of lenticular remains, but resorption of the capsule cannot be counted upon. Complete, or nearly complete disappearance in time of the thin membrane from the pupillary region, however, may often be encountered, owing to the shrinkage and retraction of the membrane behind the iris; but resorption of dense membranes, particularly those of a complicated secondary cataract, cannot be relied on.

The numerous surgical methods employed for a secondary cataract may be divided into two groups. The first group comprises operative procedures performed upon the membrane, the iris, or both—one or more incisions, discission, tearing, sawing, one or more punctures, etc. The operations of the second group involve a more radical and, it may be noted here, more feasible intervention, i.e. partial or complete removal of the membrane, removal of the membrane together with a segment of the iris, or removal of segments of the latter only from the eye.

We have proposed an original method for extraction of the membrane, which we have been employing since 1931 (Rabinovich, 1931, 1933, 1961).

Technique. A puncture is made on the limbus at a point on the meridian along which the strongest synechiae are located, but opposite to them: these synechiae have to be removed first of all. By rotating the knife around an imaginary axis perpendicular to a point between the edges of the puncture wound, we dissect the synechiae located on the side of the sharp edge of the knife, then we turn the knife around its length and advance it in the opposite direction, thus dissecting the remaining synechiae. If the latter are so strong that they cannot be dissected with a knife, forceps-scissors or small thin scissors have to be used. A small incision has to be made in order to introduce one of these instruments. This is performed by withdrawing the knife from the eyeball not by merely pulling it out, but by advancing its sharp edge sideways along the limbus, as is done to extend an incision made with a keratome. Then the scissors are introduced into the eyeball, the blades are inserted under the iris, and destruction of the synechiae is completed. The membrane freed from the adjoining tissues is extracted with a hook or forceps. The further stages of the operation are identical with those described for the extraction of a primary cataract. The postoperative period usually follows a smooth course, and the regimen can be less strict than that prescribed after an operation for extraction of a primary cataract.

The results obtained with this technique by us and other surgeons leave little to be desired: its complications are minimal and relapses are not encountered. The visual results are very high.

In conclusion, a few words should be said about a condition which, though not a true secondary cataract from the clinical and surgical point of view, is closely connected with it. We have in mind the membrane that forms with condensation of the hyaloid membrane and the anterior layers of the vitreous. This process is usually encountered when the vitreous prolapses into the anterior chamber and is retained there. With time, the vitreous shrinks and retracts, but the membrane of connective tissue causes extreme visual impairment.

Treatment consists in surgical removal of the central parts of the membrane.

CHAPTER 8

POSTOPERATIVE RESULTS. APHAKIA

Owing to a number of factors that will be discussed here the visual acuity of the eye gradually improves in the course of time following a successful operation, reaching a maximum and becoming stable after a fairly lengthy period; this visual acuity may be considered as final.

Any of the complications, early or late, described in the preceding chapter may cause a disturbance of this natural gradual improvement of vision in the postoperative period. Experience has shown that the final remote optical results can only be estimated when the test of time has been passed (a period of eight to ten months).

The final acuity of the eye operated on is the principal and decisive criterion for evaluating the results. There is no need to insist that it should be determined with correction, including correction of astigmatism if that is present.

The eye loses its lens as a result of cataract extraction, and the following changes take place: the anterior chamber becomes deeper, the iris trembles, the pupil turns black (if no lenticular remnants have been left), and, what is most important, refraction becomes weaker. The condition is known as *aphakia*.

To obtain a full and clear idea of the changes in refraction, it should be recalled that the lens is responsible for 19.11 D of the total refractive power of the eye (which is about 60.0 D). As a consequence, the parallel rays of light are focused not on the usual spot, i.e. at a distance of 22.8 millimetres (the average focal length of a healthy human eye), but at a distance of 31 millimetres. For the rays to be focused on the retina, a +10.0 or a +11.0 D converging lens has to be placed before the eye, as is done in practice. Two factors are responsible for the disparity

in the refractive power of the lens in situ with that of the corrective lens, expressed in diopters (the difference amounting to 8.0 or 9.0 D). Firstly, while the centre of a lens in situ lies at a distance of 18 to 19 millimetres from the retina, the centre of the corrective lens in spectacles is 30 millimetres from the retina. Secondly, in accord with the laws of optics, extremely complicated changes occur in the refractive power of an optical system when any part of it is removed; no clear idea of the actual situation can be obtained from simple arithmetic (subtraction in this case).

The vision is first tested during the first change of dressings by showing fingers at a distance between half and one metre. The test itself, and its results, exert an extremely favourable effect on the patient (with a successful operation, of course). Being convinced that he can see with the eye, the patient is reassured and is put in a mood, that encourages rapid recovery. An exception must be made when no perception of form can be expected during the first change of dressings, that is, in cases when blood, lenticular remnants, etc., have been left in the region of the pupil.

When the eye is quiet, visual acuity may be tested in more detail in three or four days (employing a test card) with approximate corrections of 8.0, 10.0 or 12.0 D; the test may be then repeated every four or five days. In most cases improvement is encountered from test to test, sometimes marked.

The dynamics of the increase of visual acuity occurring with time and revealed in studies of the remote results is extremely interesting and deserves the closest attention. While its gradual increase in the first postoperative days is due to the disappearance of such phenomena as blepharospasm, irritation of the eye, and photophobia, to the resorption of blood, lenticular remnants (following extracapsular extraction), lens opacities, etc., and to the disinhibition of the patient's own negative suggestion, its further improvement is caused by factors of a different nature.

The most important factor is the character of the section made to extract the cataract (its evenness, its site, the degree of trauma suffered by the tissues, etc.). It is extremely important as concerns healing and influences the

outcome of the operation. But however adequately the section is made, its cicatrization affects the shape of the eyeball, and of its principal refractive media, particularly of the cornea. The refractive power of the eye changes as a result, postoperative astigmatism developing in most cases. According to a follow-up made by Tron (1924), the degree of astigmatism varied from 1.0 to 22.0 D two weeks after the operation, declines markedly in six to eight weeks, and then becomes permanent. In his view the astigmatism depends to a great extent upon the site of the section and upon the course of the postoperative period. Kulieva (1957) published almost similar data (0.5 to 21.0 D).

Observations made by Dolganov (1894) showed that the degree of postoperative astigmatism ('traumatic', in his terminology) depended upon the evenness of the section, its length, and the time taken to heal. Ingrowth of the iris, of strands of the capsule, or of vitreous fibrils into the wound exerted a negative effect upon the healing process. Contraction of the scar in both the longitudinal and the transverse directions is the immediate cause of astigmatism. Other factors, like the pressure exerted against the eyeball by its external muscles, anterior synechiae, vitreous loss, etc., are less important. As the scar forms and becomes stronger, the deformation of the eyeball is reduced, and refraction conditions improve, and so visual acuity increases. This is the primary factor in the dynamics of the gradual improvement of visual acuity following cataract extraction.

We recently observed a case of interest in regard to this problem.

K. M., a 72-year-old physician, underwent extracapsular extraction of the lens complicated by postoperative hyphaema. We examined the patient for the first time two months after the operation; as far as could be judged retrospectively, vitreous loss had occurred during the operation: the pedicles of the coloboma of the iris were folded to the back. The postoperative scar was uneven, involving part of the limbus and part of the cornea and sclera. The patient stated that after the operation the visual acuity of the eye operated on was at first low and refractive errors could not be corrected; only a very powerful cylindrical lens (evidently no less than +14.0 or +16.0 D) in combination with a weak spherical one (the patient was myopic) produced fairly poor visual acuity. Visual acuity of

0.7 to 0.8 was finally gained many months after the operation by means of a compound lens (Convex sph. +2.5 D, Convex cyl. +12.0 D with an oblique axis).

A second factor of importance in the increase of visual acuity is the gradual clearing of the optical media, the vitreous in particular (if it has been injured and opacities formed within it), and also of the lenticular and capsular remains, blood, pigment cells, etc., encountered following an extracapsular extraction. These remains disappear, with rare exceptions, under the effect of therapy and with time, the media acquire their initial transparency, and the visual acuity increases correspondingly.

A third factor consists in the following. The long-term inactivity of the retina due to the presence of an optical hindrance leads to a condition known as torpor retinae marked by impairment of perception. It can be compared with the condition encountered in other organs or limbs that have been inactive for a long time. In support of the correctness of this idea, we may cite the following: as is well known, long-term training by means of special exercises markedly improves visual acuity from several one hundredths to several one tenths in amblyopic eyes, the low vision in which is caused by functional disorders and not by anatomical defects. This has been encountered in very many cases of amblyopia occurring in concomitant strabismus.

A fourth factor responsible for gradual improvement of vision, in some patients at least, is the following. The visual image begins to fade in blind person some time after he loses sight in both eyes. The period within which this occurs depends upon the age of the individual; with children who become blind before five or six this period lasts from two to four years, while with adults and elderly individuals visual image fades within seven to ten years (Pokrovsky, 1953). This refers to those relatively few patients in whom for some reason there has been loss of vision in both eyes for a long time, owing to which visual images have either faded completely or have become very weak. Their rehabilitation is relatively slow and time is needed for them to be restored completely. This hypothesis is well illustrated by Ognev's experimental findings (which refer

to changes occurring in the organs of goldfish after they have been kept in the dark for three years; cited from Popov and Farberov, 1958), which showed that the ganglion cells and nerve fibres had disappeared from the retina, which fully explains the development of blindness in the fishes. We cannot, of course, automatically apply all the results obtained in experiments on animals to human beings, but certain parallels and analogies are quite admissible.

The cases referred to are rarely encountered, but any experienced ophthalmologist has attended some. Our considerations should be borne in mind when the potential visual possibilities and prognosis are evaluated.

A fifth factor that should be taken into account is of a psychogenic nature. We deem it appropriate to recall here the interesting and very demonstrative experiment made by Westheimer (1957) illustrating the significance of the mental state for the function of the eye. While studying certain properties and peculiarities of accommodation under special conditions, the author intentionally caused the individual examined to be angered and found that the tension of accommodation increased to 1.0 D.

Some patients display a peculiar guardedness and restraint after an operation for cataract when their visual acuity is tested and respond to the examination with reluctance, not showing the true vision in the eye operated on. It is only after persuasion and certain amount of encouragement that their visual acuity can be assessed correctly and it usually proves to be 0.1 to 0.2 higher than that shown initially. Such behaviour is far from an act of simulating; it is a peculiar "escape into the disease" and differs from simulation by the absence of ulterior motives. The patient does not believe that he can see so well. With time and under the influence of measures to affect the second signalling system, disinhibition occurs, he loses his disbelief in his own competence, and interprets his abilities correctly. All the factors discussed fully explain the gradual improvement of visual acuity in patients whose sight has been restored as the result of an operation.

The following tactics are recommended when prescribing corrective glasses for patients who have undergone cataract extraction. Upon discharge from the clinic or hospital the

patient is prescribed glasses that afford the visual acuity optimal for that time. Vision is tested one or two months later, and depending on the condition of the optical system of the eye operated on, more suitable new glasses are prescribed (with correction of any astigmatism), or the old ones are retained.

It is advisable to check the correctness of the glasses from time to time since further changes in refraction are possible.

While on the subject of correction, we would dwell upon two new methods, one of which may be considered the current one and universal, and the other a method of the future.

The first method involves the use of a contact lens placed behind the eyelids. It is made of glass or acrylate, a stronger material of higher quality. Contact lenses correct refractive errors in the best way possible but are particularly valuable in such conditions, as keratoconus and aphakia, which interest us here. They are extremely valuable in monocular aphakia with good visual acuity in the other eye. It is known that the anisometropia occurring in that condition causes distressing optical discomfort in the patient due to the image in the aphakic eye being 25 per cent larger than that in the healthy eye (aniseikonia). A contact lens on the aphakic eye reduces this to 5 per cent, restores binocular vision, and preserves fusion. This allows cataract extraction to be performed when the second eye is healthy, a procedure justly renounced by many ophthalmologists for considerations mentioned.

We have called this method of correction of refractive errors the current one because it is gradually being acknowledged and has every chance of becoming widely used in the immediate future.

A second method was suggested by Ridley (1952). It consists in replacing the extracted lens by an artificial one. This lens-prosthesis imitates the shape and size of the living lens as well as its optical features (index of refraction and other parameters). It is implanted into the capsular remnants and becomes fixed to the surrounding tissues. The prosthesis has great advantages: there is no aniseikonia; binocular vision becomes restored; there is no need

to have two pairs of glasses since the artificial lens corrects far vision and only the usual presbyopic glasses need to be worn.

Interesting data were published by Paufique (1954): binocular vision was restored in 15 patients of 29 who were supplied with a lens-prosthesis (the visual acuity of the other eye being good). According to Rougier (1954), 85 per cent of patients with monocular aphakia acquired binocular vision when they had an artificial lens, and 32 per cent, when they wore a contact lens.

Ridley voices the opinion that the implantation of an artificial lens does not increase the incidence of postoperative complications; however, disagree others (Miller, 1953; Krasnov, Petropavlovskaya, and Khvatova, 1963; Purshev, 1963; and others). They consider that the artificial lens has a number of drawbacks which contraindicate its wide use, the foremost being a marked reaction to the trauma inflicted by the introduction of the foreign body into the eye, the possibility of partial or complete dislocation on the prosthesis into the vitreous, the precipitation of an exudate on its anterior surface, secondary glaucoma, infection, etc.

In describing the merits of the operation, Riddel (1954) calls for a cautious approach because of the possible development of complications.

Smith (1956) made a histological examination of nine eyes enucleated after implantation of an artificial lens and revealed that the latter was immured in fibrinous growth and adhesions.

Schreck (1956) suggested that the artificial lens be implanted in the anterior chamber and not in the capsular remains and alleged this method to be absolutely safe, particularly when the procedure is performed not during extracapsular extraction but several weeks later after postoperative irritation had disappeared.

Lenses made of silicate glass excite the least reaction and may therefore be considered the most suitable.

In sum, it should be said that the question of the fitness of the artificial lens and the tolerance of the patient to it have still to be elucidated; the future will show what practical significance they have.

The ultimate aim of a cataract extraction is to provide the eye with maximum visual acuity of which it is capable. We deem it advisable to discuss this subject in historical retrospect. A visual acuity of 0.3 to 0.35 following extraction of a cataract was regarded by ophthalmic surgeons as an achievement a few decades ago. It is not inappropriate to recall here the remark of Mandelstamm, the great clinician (1892) acknowledging his scepticism of the reports made frequently by some surgeons that they had achieved complete visual acuity, and calling these surgeons "lucky minions of fortune". That opinion is not in harmony with modern times. The current results of cataract extraction convince us that the visual acuity in the eye operated on often becomes very high, 1.0 and even 1.5 in individual cases.

Two examples may be cited in support of this statement.

N. M., 30 years old, received eye injuries in World War II; bilateral complicated secondary cataract following extraction of traumatic (primary) cataract. On admission to the clinic, visual acuity in the right eye was 0.02 (with correction) and in the left eye, 0.03. The after-cataract membranes were extracted by the method proposed by us (Rabinovich, 1949, 1961). Visual acuity on discharge: right eye 0.06 with +12.0 D = 1.0, near vision—with +16.0 D, reads No. 3 test-type; in 12 and 22 months visual acuity was 0.06 without correction and 1.5 with a 12.0 D corrective lens. Visual acuity of the left eye was 1.0.

G. P., a 60-year-old physician. An immaculate intracapsular extraction was performed by an experienced ophthalmic surgeon. Six months later visual acuity was 1.5.

These results and those of a number, small it is true, of identical cases should be regarded as particularly successful; but a very high visual acuity following cataract extraction (at least following extraction of an after-cataract) is not so rare an occurrence.

We may illustrate this statement by some figures on the results of intracapsular extractions performed by us. On discharge from the clinic visual acuity of 0.8 to 1.0 was found in 26 per cent of the patients operated on, and visual acuity of 1.0 in 60 per cent. The remote results in this group proved better still: 60 and 50 per cent respectively, while in one patient visual acuity reached 1.5.

Comparison with the results obtained in other clinics shows that ours are not unique or exceptional.

Akhundova (1963) reports that visual acuity in patients on whom she operated was often as high as 0.9 to 1.0. Similar results are obtained by other ophthalmic surgeons.

Birchenko (1961) obtained visual acuity of 0.6 to 1.0 in 15 per cent of a group of over 200 patients who underwent intracapsular extraction.

Of great interest are data comparing the results of intra- and extracapsular extractions.

Bochever (1947) reports that visual acuity of 0.7 to 1.0 was encountered in 76 per cent of patients following intracapsular extraction, but only in 19 per cent following extracapsular.

Litvak (1961) presents data on 1,171 operations, 839 (71.65 per cent) of which were made by the intracapsular technique and 332 (28.35 per cent) by the extracapsular. Visual acuity of 1.0 was achieved in 40 per cent of the patients of the first group and in 25 per cent of those of the second group; the corresponding figures for patients with visual acuity of 0.8 to 1.0 were 53 and 23 per cent.

All these data clearly point to the advantages of intracapsular extraction over the extracapsular method. These advantages become even clearer when we compare data concerning complications encountered during both operative methods, facts that dispel the prejudiced myth that intracapsular extraction of cataract is a risky procedure.

BIBLIOGRAPHY

Adamyuk, E. V. (1885). Manual for studying diseases of the eye (Prakticheskoe rukovodstvo k izucheniyu boleznei glaza). Kazan.

Arkhangelsky, V. N. (1943). Preventive features in operative methods involving incision of the anterior chamber (Profilaktícheskie momenty v metodakh operatsii so vskrytiem perednei kamery). Vestnik Oftalmologii, 3, 4.

Avakian, U. M. (1960). On the theory of X-ray perception by the human eye (K teorii vidimosti rentgenovskikh luchei glazom cheloveka). Electroretinographia. Lékar. fak. univ. J. E. Purkyne, Brno, 105-108.

Axenfeld, Th. (1909). Lehrbuch der Augenheilkunde. Jena.

Barkov, N. (1962). Potentiation (Potentsirovanie). Bolshaya Meditsinskaya Entsiklopediya, 26.

Barraquer, J. (1958). Totale Linsenextraction nach Auslösung der Zonula durch α-chymotrypsin-enzymatische Zonulalyse. Klin. Mtsbl. Augenh., 133, 5, 609-615.

Becker, O. Pathologie und Therapie des Linsensystems. In: Graefe A. und Saemisch Th. Hdb der gesammten Augenheilkunde. Leipzig, 1876-1877, 5, 157-520.

Bell, A. F. (1948). Modified Erisophake. Amer. J. Ophth., 31, 610.

Bellows, J. G. (1944). Cataract and anomalies of the lens. London.

Belostotsky, E. M. (1956). Contact lens made of plastic. Theses of a report made to the All-Union conference of ophthalmologists and the 20th session of the Helmholts State Scientific Research Institute of Eye Diseases, Moscow-Kuibyshev, Nov., 1956 (Kontaktnye ochkovye linzy iz plastmassy. Tezisy po dokladu na Vserossiiskom soveshchanii glaznykh vrachei i XX vyezdnoi sessii Gosudarstvennogo Nauchno-Issledovatelskogo Instituta Glaznykh Boleznei im. Gelmgoltsa, Moskva-Kuibyshev, noyabr, 1956), 203.

Birchenko, L. A. (1961). Intracapsular extraction of senile cataracts employing airtight sutures. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbi-

lisi (Ob intrakapsulyarnoi ekstraktsii starcheskikh katarakt s nalozheniem germeticheskogo shva. Materialy II Vsesoyuznoi konferentsii oftalmologov, 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 357-358.

Bochever, E. M. (1947). Remote results of intracapsular and extracapsular cataract extraction (Otdalennye rezultaty intra- i ekstrakapsulyarnoi ekstraktsii katarakty). Vestnik Oftalmologii, 26, 5, 27-30.

Callahan, A. (1956). Surgery of the eye diseases. Springfield.

Chandler, P. (1954). Complication after cataract extraction: clinical aspects. Trans. Amer. Acad. Ophthalm. Otolaryng., 58, 382.

Chechik-Kunina, E. A. (1940). Comparative evaluation of operative methods employed for removal of soft cataracts. Transactions of the Central Helmholts Institute of Ophthalmology (Sravnitelnaya otsenka operativnykh metodov, primenyaemykh pri udalenii myagkikh katarakt. Trudy Tsentralnogo Instituta Oftalmologii im. Gelmgoltsa). Moscow-Leningrad, 54-63.

Coscas, G., Halimi, G. (1966). Arch. ophtalmol. Paris, 26, 5, 779-796.

Danilevsky, I. A., Veremeenko, K. N. (1961). Experience in the use of Soviet alpha-chymotrypsin during intracapsular cataract extraction. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Opyt intrakapsulyarnoi ekstraktsii katarakty s pomoshchyu otechestvennogo alfa-khimotripsina. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 346-347.

De Rosa, L. (1958). Si di un caso di oftalmite simpatica trattato con cortisone. Ann. Oftalmol. e. Clinica Oculist., 84, 4, 165-171.

Dolganov, V. N. (1894). Wound corneal astigmatism following extraction of the lens (O ranevom astigmatisme rogovoi obolochki posle ekstraktsii khrustalika). Vestnik Oftalmologii, 11, 388.

Duke-Elder, W. S. (1945). Text-book of ophthalmology, London, vol. 3.

Dunphy, E. B. (1928). Loss of vitreous in cataract extraction. J. Am. Med. Assoc., 89, 22, 54.

Dyment, P. A. (1960). Evaluation of the efficacy of early surgical intervention for traumatic intumescent cataracts (Otsenka effektivnosti rannego khirurgicheskogo vmeshatelstva pri travmaticheskikh nabukhayushchikh kataraktakh). Oftalmologicheskii Zhurnal, 2, 72-76.

Efet, V. A. (1961). Pathogenetic substantiation of non-surgical management of incipient senile cataracts. Proceedings of the second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Patogeneticheskoe obosnovaniye konservativnogo lecheniya nachalnykh stadii starcheskikh katarakt. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 301-303.

Elschnig, A. (1932). Die intracapsulare Starextraction. Berlin.

Filatov, V. P. (1933). New measures for control of expulsive haemorrhage (Novye puti v borbe s ekspulsivnoi gemorragiey). Sovetskii Vestnik Oftalmologii, 3, 1.

Forchheimer, L. L. (1955). Topical use of cortisone in sympathetic ophthalmia. Amer. J. Ophthalm., 40, 2, 248-251.

Forest A., Haut E. (1966). Arch. Ophthalmol., 26, 3, 249-252.

Fradkin, M. Y. (1947). The role of ascorbic acid in the vital activity of the lens (Rol askorbinovoi kisloty v zhiznedeyatelnosti khrustalika). Vestnik Oftalmologii, 26, 6.

Fradkin, M. Y., Vilenkina, A. Y., Itsikson, L. I., Vainshtein, E.S. (1963). Non-surgical treatment of incipient cataracts. In the collected articles: Cataracts. Scientific Papers. Helmholts State Scientific Research Institute of Eye Diseases (Konservativnoe lecheniye nachalnykh katarakt. V sb.: Katarakty. Uchenye Zapiski. Gosudarstvennyi Nauchno-Issledovatelskii Institut Glaznykh Boleznei im. Gelmgoltsa), Moscow, 8.

Franceschetti, A. (1955). New operations and some special indications and techniques in ophthalmic surgery. Am. J. Ophthalm., 39, 189-197.

Giardini, A. (1956). Assensa di camera anterior dopo estrazione di cataracta. Bol. oculist., 35, 275.

Gnetova, O. E. (1961). Corneoscleral sutures in cataract extraction. Proceedings of the Second All-Union conference of ophthalmologists Oct. 11-14, 1961, Tbilisi (Korneoskleralnye shvy pri ekstraktsii katarakty. Materialy II Vsesoyuznoi konferentsii oftalmologov 11-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 353-355.

Graefe A. von. Note sur la guérison du glaucome adressé à l'Institute de France.

Gramberg-Danielsen, B. (1959). Die unmittelbare Sichtbarkeit der Röntgenstrahlen. Klin. Mtsbl. Augenheilk., 134, 172-178.

Gundorova, R. A., Fridman, F. E., Morozov, V. I., and Polyakova, L. Y. (1963). On modern methods of treatment of traumatic cataracts. In the collected articles: Cataracts. Scientific Papers.

Helmholts State Scientific Research Institute of Eye Diseases (K voprosu o sovremennykh metodakh lecheniya travmaticheskikh katarakt. V sb.: Katarakty. Uchenye Zapiski. Gosudarstvennyi Nauchno-Issledovatelskii Institut Glaznykh Boleznei im. Gelmgoltsa). Moscow, 8.

Hofmann, H. (1959). Trypsin in der Augenheilkunde. Klin. Mtsbl. Augenh., 134, 4, 532.

Hoorens, A. (1961). Over de potantializering der pupillaire effecten van adrenaline en noradrenaline door cocaine. Verhandel Konikl. Vlaamse Acad. Geneeskunde Berlgie, 23, 5, 330-351.

Kolenko, A. B. (1959). On the pathogenesis and therapy of radiation cataracts (O patogeneze i terapii luchevykh katarakt). Oftalmologicheskii Zhurnal, 4, 195-200.

Kornblum, E. Y. (1950). Experience in the use of sleep therapy in ophthalmology (Opyt ispolzovaniya lecheniya snom v oftalmologii). Vestnik Oftalmologii, 29, 6, 3-6.

Kovalev, I. F. (1959). Primary radiation injuries to the lens and their role in the development of radiational cataract (Pervichnye luchevye povrezhdeniya khrustalika i ikh rol v razvitii katarakty). Oftalmologicheskii Zhurnal, 6, 353-358.

Kovalev, I. F. (1961). Developmental peculiarities of radiation cataracts in animals of different age groups. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Osobennosti razvitiya luchevykh katarakt u zhivotnykh razlichnykh vozrastnykh grup. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 191-197.

Krasnov, M. L., Shulpina, N. B. (1958). Ophthalmologist's handbook on drugs (Lekarstvennyi spravochnik vracha-oftalmologa). Moscow.

Krasnov, M. M., Petropavlovskaya, G. A., Khvatova, A. V. (1963). Experimental studies of the reaction in a rabbit's eye to an artificial lens, made of silicate or organic glass, implanted into the anterior chamber. In the collected articles: Cataracts. Scientific Papers. Helmholts State Scientific Research Institute of Eye Diseases (Eksperimentalnoe izuchenie reaktsii glaza krolika na implantatsiyu v perednyuyu kameru iskusstvennogo khrustalika iz silikatnogo i organicheskogo stekla. V sb.: Katarakty. Uchenye Zapiski. Gosudarstvennyi Nauchno-Issledovatelskii Institut Glaznykh Boleznei im. Gelmgoltsa). Moscow, 8.

Kulieva, Z. T. (1957). Fluctuations of corneal refraction and visual acuity after cataract extraction (Kolebaniya refraktsii rogovitsy i ostroty zreniya posle ekstraktsii katarakty). Azerbaidzhansky Meditsinskii Zhurnal, 6, 75-79.

Litvak, P. I. (1961). Modification of the intracapsular cataract extraction operation. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Modifikatsia operatsii intrakapsulyarnoi ekstraktsii katarakty. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 352-353.

Magilnitsky, S. G., Ferber, B. M., and Kholmetskaya, R. M. (1961). The use of the enzyme alpha-chymotrypsin during intracapsular cataract extraction. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Primeneniye fermenta alfa-khimotripsina dlya intrakapsulyarnoi ekstraktsii katarakty. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 344-347.

Mandelshtamm, E. (1892). Clinical lectures on diseases of the eye (Klinicheskie lektsii po glaznym boleznyam), Kiev.

Odintsov, V. P., Orlov, K. Kh. (1934). Manual of surgery of the eye (Rukovodstvo glaznoi khirurgii). Moscow-Leningrad, 2, 845.

Orlova, E. M. (1959). Main problems of correction of vision by contact lenses (Osnovnye voprosy korrektsii zreniya kontaktnymi linzami). Dissertation, Moscow.

Orlova, E. M., Shkatova, A. F. (1963). Correction of monocular aphakia by contact lenses. In the collected articles: Cataracts. Scientific Papers. Helmholts State Scientific Research Institute of Eye Diseases (Korrektsia monokulyarnoi afakii kontaktnymi linzami. V sb.: Katarakty. Uchenye Zapiski. Gosudarstvennyi Nauchno-Issledovatelskii Institut Glaznykh Boleznei im. Gelmgoltsa). Moscow, 8.

Pagenstecher, H. (1888). Über Staroperation mit und ohne Entfernung der Kapsel. Graefes. Arch., 34, 2, 167.

Paufique, L. (1954). Ridley's operation. Technique, complications, indications. Bull. et mem. Soc. Tranc. Ophthalm., 67, 378.

Pavlov, N. M., Vladimirova, E. F. (1952). The influence of sleep therapy on the functions of the organ of vision (Vliyanie terapii snom na funktsii organa zreniya). Vestnik Oftalmologii, 31, 13-17.

Pincus, M. H. (1950). Epithelial invasion of anterior chamber following cataract extraction: effect of radiation therapy. Arch. Ophthalm., 43, 509-519.

Pirie, A. (1965). Invest. Ophthalmol., 4, 629-637.

Pokrovsky, A. I. (1953). On the development of visual perception and judgement on recovery of vision following an operation,

in the light of the works of Academician Pavlov (K voprosu o razvitii zritelnykh vospriyatii i suzhdenii u prozrevshikh posle operatsii v svete rabot akad. I. P. Pavlova). Vestnik Oftalmologii, 32, 6, 6.

Poos, F. (1930). Der Anteil der beiden Antagonisten an den Pupillenbewegungen bei verschiedenen Refractionen. Graefes Arch. Ophthalm., 125, 308.

Popov, V. V., Farberov, A. I. (1958). The effect of light on corneal induction. Higher School Scientific Reports. Biological sciences (Vliyanie sveta na induktsiyu rogovitsi. Nauchnye Doklady Vysshei shkoly. Biologicheskiye nauki), 3, 48-60.

Protopopov, B. V., Murzin, A. A. (1961). The use of proteolytic enzymes in ophthalmological practice. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (Primenenie proteoliticheskikh fermentov v glaznoi praktike. Materialy II Vsesoyusnoi Konferentsii Oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 342-344.

Purshev, F. I. (1963). Remote results of implantation of a plastic artificial lens into the eye. In the collected articles: Cataracts. Scientific Papers. Helmholts State Scientific Research Institute of Eye Diseases (Otdalennye rezultaty implantatsii v glaz iskusstvennogo khrustalika iz plastmassy. V sb.: Katarakty. Uchenye Zapiski. Gosudarstvennyi Nauchno-Issledovatelskii Institut Glaznykh Boleznei im. Gelmgoltsa). Moscow, 8.

Rabinovich, M. G. (1931). Endophthalmitis due to hypersensitivity to lens proteins (Endoftalmit na pochve povyshennoi chuvstvitelnosti k khrustalikovym belkam). Russkii Oftalmologicheskii Zhurnal, 13, 4.

Rabinovich, M. G. (1931). On the saturation of the cornea with blood (K voprosu o propityvanii krovyu rogovitsi). Russkii Oftalmologicheskii Zhurnal, 13, 185.

Rabinovich, M. G. (1933). On the removal of secondary cataract (with the demonstration of patients). Report made to the scientific conference of physicians of the Baku Central Eye Hospital, November 22, 1931 (K voprosu ob udalenii vtorichnoi katarakty [s demonstratsiey bolnykh]). Doklad na nauchnoi konferentsii vrachei Bakinskoi Tsentralnoi Glaznoi Bolnitsy 22 noyabrya 1931 g. Ref.: Sovetskii Vestnik Oftalmologii, 2, 4.

Rabinovich, M. G. (1933). Modification of the corneal suture in cataract extraction (Modifikatsiya rogovichnogo shva pri izvlechenii katarakty). Sovetskii Vestnik Oftalmologii, 3, 4.

Rabinovich, M. G. (1933). Maximum pupillary dilation and complete anaesthesia induced by placing cotton soaked in a co-

caine-adrenalin solution behind the lower eyelid (Maksimalnoe rasshireniye zrachka i polnaya anesteziya s pomoshchyu vatki, propitannoi rastvorom kokaina-adrenalina, zakladyvaemoi za nishnee veko). Ref.: Sovetskii Vestnik Oftalmologii, 3, 4.

Rabinovich, M. G. (1947). Sympathetic ophthalmia during World War II. In the collected papers: Military eye injuries and their treatment. Ed. by A. S. Savvaitov (Simpaticheskaya oftalmiya v period Velikoi Otechestvennoi voiny. V sb.: Boevye povrezhdeniya glaz i ikh lecheniye. Pod red. A. S. Savvaitova). Moscow, 122-125.

Rabinovich, M. G. (1948). The use of vitamin K in ophthalmology. Scientific Papers in Memory of Academician M. I. Auerbakh (Primeneniye vitamina K v oftalmologii. Sbornik Nauchnykh Rabot, Posvyashchonnyi Pamyati Akad. M. I. Auerbakha). Izd. AN SSSR. Moscow.

Rabinovich, M. G. (1949). Surgical treatment of secondary cataracts (Khirurgicheskoye lecheniye vtorichnykh katarakt). Diss. dokt. Moscow.

Rabinovich, M. G. (1956). Experience in drug therapy of incipient senile cataracts (Opyt medikamentoznogo lecheniya nachalnykh form starcheskoi katarakty). Moscow.

Rabinovich, M. G. (1961). Secondary cataract (Vtorichnaya katarakta). Moscow.

Radnót, M. (1960). Clinical experience and experimental observations with alpha-chymotrypsin. Acta chirurg. Acad. Sci. Hung., 1, 1, 3-7.

Riddel, W. (1954, 1955). Clinical selection for the acrylic lens operation. Acta chir. XVII Con. ophthalmol., 1, 200.

Ridley, H. (1952). Intraocular acrylic lenses. Brit. J. Ophthalm., 36, 3, 13.

Rougier, J. (1954). Correction of unilateral aphakia by contact lenses and by Ridley lenses. A comparative study. Bull. et Mem. Soc. Trans. Ophthalmol., 67, 391.

Schreck, E. (1956). Erfahrungen mit Vorderkammerlinsen. Klin. Mtsbl. Augenh., 129, 1, 112.

Shevalyov, V. E. (1961). Techniques of extraction of radiation cataracts. Proceedings of the Second All-Union conference of ophthalmologists, Oct. 10-14, 1961, Tbilisi (O metodike ekstraktsii luchevykh katarakt. Materialy II Vsesoyuznoi konferentsii oftalmologov 10-14 oktyabrya 1961 g. Tbilisi). Tbilisi, 215-217.

Shmeleva, V. V. (1963). Extraction of a cataract by means of an erysiphake (Ekstraktsia katarakty erizofakom). Vestnik Oftalmologii, 2, 44-48.

Skvorcherskaya, L. A. (1952). Theses of the report on sleep therapy in glaucoma. Fourteenth scientific session of the Helmholts State Central Institute of Ophthalmology (Tezisy k dokladu "Lecheniye glaukomy snom". 14-aya nauchnaya sessiya Gosudarstvennogo Tsentralnogo Instituta Oftalmologii im. Gelmgoltsa). Moscow, 33.

Smith, B. (1956). Histopathological studies of the eye enucleated after failure of intraocular acrylic lens operation. Brit. J. Ophthalm., 40, 473.

Stanculeanu, G. (1912). Intracapsuläre Staroperationen. Klin. Mtsbl. Augenh., 1, 527-537.

Strampelli, B. (1954). Sopportabilita di lenti acriliche in camera anteriore nella afachia. Ann. Oftalmol. e clin. Ocul., 80, 75.

Sverdlov, D. G. (1956). Artificial acrylic lens (Review of the literature). Iskusstvennyi khrustalik. (Obzor literatury). Vestnik Oftalmologii, 6, 36.

Tikhomirov, P. E. (1956). Intracapsular cataract extraction performed by means of a simplified erysiphake (Ekstraktsiya katarakty v kapsule uproshchennym erizofakom). Vestnik Oftalmologii, 4, 35-37.

Török, E. (1916). Extraction of cataracts in the capsule by a slight modification of the von Graefe method. Ann. Ophthalm., 25, 712-717.

Tron, E. Z. (1924). Certain particular features of astigmatism following cataract extraction in association with the problem of the shape of the cornea (O nekotorykh osobennostyakh astigmatisma posle ekstraktsii katarakty v svyazi s voprosom o forme rogovitsy). Russkii Oftalmoligicheskii Zhurnal, 3, 5.

Van Lint, A. (1914). Paralyse palperale temporaire provoquée dans l'operation de la cataracte. Ann. d'Ocul., 420.

Varshavsky, Y. K., Rabinovich, M. G. (1933). Intracapsular cataract extraction (Izvlechenie katarakty v sumke). Sovetskii Vestnik Oftalmologii, 3, 3.

Vasilevich, A. E. (1961). Intracapsular extraction of cataract performed on patients with high myopia (Intrakapsulyarnaya ekstraktsiya katarakty u bolnykh s vysokoi stepenyu blizorukosti). Avtoreferat. Vestnik Oftalmologii, 6, 75-77.

Velhagen, K. (1958). Pharmakologie in der Ophthalmologie. In: Der Augenarzt. Leipzig, 1.

Verhoeff, F. H. (1915). Scleral puncture for expulsive sub-choroidal hemorrhage following sclerotomy—scleral puncture for postoperative separation of the choroid. Ophthalm. Res., 24, 55-59.

Vogt, A. (1922). Weitere Ergebnisse der Spaltlampenmicroscopie des vorderen Bulbusabschnittes. IV Abschnitt. Praesenile und senile Linsentrübungen. Arch. f. Ophthalm., 108, 192-218.

Walser, E. (1958). Erste Erfahrungen über fermentative Zonulalyse bei der Staroperation. Klin. Mtsbl. Augenh., 133, 5, 619-624.

Westheimer, G. (1957). Accommodation measurements in empty visual fields. J. Opt. Soc. Am., 47, 8, 714.

Zamkovsky, Y. G. (1941). Oxygen therapy of the eye (Oksigenoterapiya glaza). Vestnik Oftalmologii, 18, 1, 71-75.

Zolotareva, M. M. (1961). Diseases of the eye (Glaznye bolezni). GOS. Izd. BSSR, 495.

Zorab, E. C. (1959). Alpha-chymo-trypsin in cataract extraction. Brit. J. Ophthalm., 43, 4, 202-203.

INDEX OF NAMES

Adamyuk, E. V., 66, 162
Akhundova, S. K., 161
Arkhangelsky, V. N., 83, 96, 162
Auerbach, M. I., 135
Avakian, V. M., 49, 162
Avicenna, 64
Awasthi, 133
Axenfeld, T., 162

Badzyma, M. K., 66
Barkov, N., 162
Barraquer, J., 95, 162
Bartisch, 64
Becker, O., 15, 162
Bell, A. F., 162
Bellows, J. G., 56, 162
Belostotsky, E. M., 162
Birchenko, L. A., 114, 161, 162
Bochever, E. M., 161, 163

Callahan, A., 86, 115, 120, 163
Celsus, 63
Chandler, P., 140, 163
Chechik-Kunina, E. A., 112, 163
Cohen, 10
Coscas, G., 80, 163

Danilevsky, I. A., 95, 163
Daviel, J., 64
De Rosa, L., 149, 163
Dolganov, V. N., 163
Duke-Elder, W. S., 25, 56, 163
Dunphy, E. B., 132, 163
Dyment, P. A., 121, 163

Efet, V. A., 21, 164
Elschnig, A., 91, 164

Farberov, A. I., 157, 167
Ferber, B. M., 95, 166
Filatov, V. P., 135, 136, 164
Forshheimer, L. L., 149, 164
Forest, A., 116, 164
Fradkin, M. Y., 13, 61, 164
Frandsen, 43
Franschetti, A., 115, 164
Fridman, F. E., 121, 164
Fuchs, L., 27

Galen, 41
Giardini, A., 140, 164
Gnetova, O. E., 83, 164
Graefe, A. von, 117, 164
Granberg-Danielson, V. B., 49, 164
Gundorova, R. A., 121, 164

Halimi, G., 80, 163
Haut, E., 116, 164
Hippocrates, 43
Hirschberg, J., 64
Hofman, H., 95, 165
Hoorens, A., 38, 165

Itsikova, L. I., 164

Janert, 71

Kholmetskaya, R. M., 95, 166
Khvatova, A. V., 159, 165
Kolenko, A. B., 165
Kopp, I. F., 121
Kornblum, E. Y., 66, 165
Kovalev, I. F., 165
Krasnov, M. L., 165
Krasnov, M. M., 159, 165
Kulieva, Z. T., 155, 165

Litvak, P. I., 161, 166

Magilnitsky, S. G., 95, 96, 166
Mandelstamm, E., 160, 166
Miller, 159
Morozov, V. I., 121, 164
Murzin, A. A., 95, 96, 167

Nesterov, A. N., 61

Odintsev, V. P., 166
Ognev, I. F., 156
Orlov, K. Kh., 166
Orlova, E. M., 166

Pagenstecher, A., 90, 166
Paufique, L., 159, 166
Paulus Aegineta, 64
Pavlov, N. M., 66, 166
Pavlova-Kaminskaya, 62
Petropavlovskaya, G. A., 159, 165
Pincus, M. H., 166
Pirie, A., 24, 166
Pirogov, N. I., 55
Pliny, 63
Pokrovsky, A. I., 156, 166
Polyakova, L. Y., 121, 164
Poos, F., 36, 167
Popov, V. V., 167
Printsev, Yu., 60
Protopopov, B. V., 95, 96, 167
Purshev, F. I., 167

Rabinovich, G. A., 131
Rabinovich, M. G., 32, 35, 37, 61, 66, 75, 81, 91, 113, 115, 141, 145, 146, 149, 167, 168, 169
Radnot, M., 168
Raizada, 133
Riddel, W., 159, 168
Ridley, H., 158, 159, 168
Rougier, J., 159, 168
Rouher, 80

Schreck, E., 159, 168
Shevalyov, V. E., 124, 168
Shkatova, A. F., 166
Shmeleva, V. V., 94, 169
Skvorchevskaya, L. A., 32, 66, 169
Smith, B., 159, 168
Stanculeanu, G., 91, 169
Strampelli, B., 169
Sverdlov, D. G., 169

Tikhomirov, P. E., 94, 169
Török, E., 91, 169
Tron, E. Z., 155, 169

Vainshtein, E. S., 164
Van Lint, A., 77, 169
Varshavsky, Y. K., 91, 113, 169
Vasilevich, A. E., 114, 169
Velhagen, K., 36, 169
Veremeenko, K. N., 95, 163
Verhoeff, F. H., 136, 170
Vilenkina, A. Y., 164
Vladimirova, E. F., 66, 166
Vogt, A., 25, 170

Walser, E., 95, 170
Westheimer, G., 157, 170

Zamkovsky, Y. G., 170
Zolotareva, M. M., 83, 114, 121
Zorab, E. C., 96, 170

SUBJECT INDEX

Accommodation function, 9
Acinesia, 74, 76f, 126, 169; technique, 77
Acrylic lenses, 159, 168, 169, *see also* Lens, artificial
Acrylic lens operation, 168, 169
Adenosine, 61
Adrenalin, 36, 37, 38, 39, 107, 119, 164, 174; as anaesthetic, 75
Adrenocorticotropic hormone, 58
Adrenomimetic agents, 36
Aetiology, 16, 55
After-cataract, 97, 98, 105, 121, 160, *see also* Cataract, secondary
Air, *see* Sterile air
Albucid, *see* Sulphamil acetamide
Allergies, 57, 65
Alpha-chymotrypsin, 95, 96, 162 163, 166, 168, 170
Amidopyrine, 58, 108, 122, 147
Aminazine, *see* Chlorpromazine
Amphetamine, 36
Anaesthesia, 71f, 75ff; instillation, 75, 111; retrobulbar, 75f, 126; with children, 111
Analgetics, 70
Andaxin, *see* Meprodamate
Aniseikonia, 158
Anterior chamber, 10, Fig. 1; failure to reform, 137ff, 141 filling of, 96, 105; epithelial invasion, 166; haemorrhage in, 141; incision of, 84ff, 129, 162; introduction of oxygen, 102 105f; irrigation of, 100, 147; paracentesis of, 147
Anterior polar cataract, *see* Cataract, anterior polar
Antibiotics, 67, 72, 146, 149
Antihistamines, 70
Antisepsis, 72
Aphakia, 153, 166, 168
Aphakic eye, 46, 158
Aqueous humour, 9, 12; escape of, 101; production of, 61
Arruga forceps, 91
Ascorbic acid, 12, 22, 59, 60, 143, 164, *see also* Vitamin C
Astigmatism, 80, 102, 153, 155, 169; wound, 163
Atherosclerosis, 59
Atropine, 36, 38, 108, 125, 143; poisoning, 126, 150
Autohaemotherapy, 59, 146

Bacteriological examination, 69f
Barbiturates, 58
Bed regimen, 124
Belladonna, 58
Bell erysiphake, 95, 162
Bilateral cataracts, 44ff
Biochemical shifts, 21, 54
Biomicroscopy, 11, 31, 35, 68, 140
"Black" cataract, 40
Blepharitis, 68
Blepharostat, use of, 74
Bridle suture, 74, 76, 77f, 128, 133, Fig. 12; technique, 77f
Bromide, 58, 70
Bullous keratopathy, 136 f
Butadione, 58

Caffeine, 58, 126, 150
Calcium chloride, 61
Canthotomy, 74
Capsule, anterior, 9f; Fig. 1; hyaline, 9; posterior, 9, Fig. 1; rupture of, 129
Carbolic acid as filler, 140

Cataract, 162;
acquired, 18ff;
prophylaxis of, 53, 54;
aetiology of, 13, 16, 56;
anterior polar, 14;
bilateral, 44ff;
"black", 40;
capsular, 14;
central, 14, 110;
classification of, 14ff;
by aetiology, 16, 55;
clinical types, Fig. 2;
complete, 14, 18, Figs. 2, 5;
complicated, 15, 25ff, 69, 75, Fig. 8;
operations for, 113ff;
congenital, 14, 16ff, 42f, 109f;
incidence of, 16;
prophylaxis, 53f;
contusion, 28f, 123
cortical, 14, Fig. 2;
diabetic, 22ff, 66, 109, Fig. 7;
incidence of, 24;
diagnosis of, 35ff;
discission of, 111f;
endocrine, 18, 22ff, 109, Fig. 22;
prophylaxis, 54;
expression of, 64;
heat, 31f, Fig. 9;
heterochromatic, 27;
hypermature, 20;
incipient, 19, 39, 164, Fig. 6;
intumescent, 20, 163;
lamellar, 14, 16, 109 f, Figs. 2, 4;
choice of operation, 110;
lightning, 32f, Fig. 10;
mature, 20;
membranous, 18;
Morgagnian, 20;
myopic, 26;
operation for, 113f, 169;
non-surgical treatment, *see* Treatment, nonsurgical;
nuclear, 14, 19, 113, Fig. 2;
physiology of, 14ff;
posterior polar, 14;
Cataract
progressive, 14, 40, 66;
prophylaxis, 52ff;
radiation, 25, 33f, 55, 123f, 165, 168, Fig. 11;
resorption, 122;
secondary, 35, 52, 150ff, 167, 168, Fig. 19, *see also* After-cataract;
treatment, 151f
senile, 15, 18, 19ff, Fig. 6;
drug therapy, 168;
incidence of, Fig. 3;
involution of, 43;
operation on, 79ff, 162;
pathogenesis of, 21f;
prophylaxis, 55;
simple, 14, 15, 16ff;
operations on, 79ff;
soft, 112f, 163;
spindle, 14, Fig. 2;
stationary, 14, 40, 42f;
traumatic, 28ff, 55, 121f, 164
Vossius', 29;
with glaucoma, 28, 118ff;
with pigmental degeneration, 26, 114f;
with retinal detachment, 26, 115f;
with tetany, 24, 66, 109, Fig. 7;
with uveitis, 27, 116ff;
zonular, 14, 111;
Cataract extraction, 74f;
complications, 127ff, 136ff, 163;
expression, 64, 99, 114;
extracapsular, 79, 93, 96, 97ff, 117, 123, Fig. 17;
indications, 44ff;
intracapsular, 52, 79, 90ff, 111, 113, 114, 117, 123f, 129f, 161f, 164;
techniques, 74ff, 168
Chalcosis, 31
Children, operations on, 44, 71, 109f, 111
Chlorpromazine, 70, 71
Cholesterol, 12, 18
Cholinomimetic agents, 36

Choroid, detachment of, 141, 142f;
re-attachment, 142
Chromatopsia, 149f
Ciliary body, 11, Fig. 1
Ciliary zonule, 10, 11, Fig. 1
Citral, 128, 137
Cocaine, 36, 37, 38f, 75, 165
Cod liver oil, 137
Collapse of the eyeball, 101f
Congenital cataract, *see* Cataract, congenital
Conjunctival flap, 80, 82f, 112, 138, 142;
complications with, 128
Conjunctivitis, 68
Contact lenses, 158f, 162, 166, 168
Contusion cataract, *see* Cataract, contusion
Cornea, erosion of, 128f;
haematogenic impregnation 141;
leucoma of 50, 110;
oedema of, 68;
pressure on, 130;
transparency of, 68
Corneal dystrophy, 136f
Corneal induction, 167
Corneal retraction, 101f
Corneal transplantation, 51
Corticosteroids, 122, 144
Cortisone, 58, 146, 149, 163, 164
Cribriform opacities, 137
Cryoextractor, 74, 112
Crystalline lens, Fig. 1;
anatomy of, 9ff;
chemical composition, 12;
transparency of, 13
Cyclitis, 15
Cysteine, 12, 21, 61f
Cystitome, 74, 97f, 112
Cysts, 140

Daviel spoon, 93, 98
Desquamation, 68
De Wecker's iris scissors, 88
Diabetes, 15
Diacarb, 139
Diagnosis, methods of, 35ff
Diamox, 119, 139, 140
Diathermocoagulation, 140
Dicaine, *see* Tetracaine
Dilation of pupil, 37, 75, 107, 115, 125f;
therapeutic, 146
Dimedrol, *see* Diphenhydramine
Dionine, 143
Diphenhydramine, 58, 70, 71
Drugs, 165, 169;
choice of, 60;
potentiation, 37f, 58, 70;
use of, 67
Drug therapy, 168
Dystrophy, corneal, 136f;
endothelial, 137

Ectropion, 68
Electroencephalography, 50
Electronic stimulator, 50
Electrophoresis, 62, 143
Electroretinography, 50
Elschnig forceps, 91
Emmetropia, 39
Endocrine cataracts, *see* Cataract, endocrine
Endogenic infection, 146, 147
Endophthalmitis, phaco-anaphylactic, 52, 97, 112, 121, 122, 145;
anaphylactic theory, 145
Enophthalmos, 27
Entropion, 68, 71
Enzymes, use of, 95, 96, 167, 170, *see also* Alpha-chymotrypsin, Zonulolytic preparations
Ephedrine, 36, 39
Epithelium, 9;
downgrowth, 140f;
invasion of anterior chamber, 166
Erysiphake, 74, 94f, 112, 123, 169;
Bell, 95, 162;
use of, 95
Exogenic infection, 69, 80, 146, 147
Extracapsular extraction, 79, 93, 96, 97ff, 117, 123, Fig. 17

Fixation of eyeball, Fig. 12
Fluorescin, 68
Forceps, 52, 91;
fixation, 74, Fig. 12
Fossa patellaris, 9
Fuchs' syndrome, 27
Functional disorders,
as contraindications, 50f
Functional disorders,
as contraindications, 50f
Fungi, 147
Furacilin, 72, 108

Glass-blowers' cataract, 31
Glasses, prescription of, 157f;
wearing of, 56
Glaucoma, 15, 28, 42, 68, 118ff, 164;
cataract with, 28, 118ff;
secondary, 25, 28, 51, 121, 133, 141, 143f
Gloves, use of, 73
Glucose, 67
Glutamic acid, 61
Glutathione, 12, 22
Glycerol, 61
Graefe knife, 84, 90;
section with, 84ff, Fig. 14*a*

Haemorrhage, arrest of, 103;
expulsive, 135f, 164, 170;
in anterior chamber, 141;
into eyeball, 145;
retrobulbar, 74
Haemotoma, retrobulbar, 127f;
subconjunctival, 128
Heat cataract, *see* Cataract, heat
Herbae leonuri, 58
Hess spoon, 98
Heterochromatic cataract, 27
Heterochromia, 25, 120f
Hirudin, 141
Homatropine, 36, 38
Horner's syndrome, 27
Hyaline capsule, 9
Hyaluronidase, 76, 77, 119
Hyperopia, 39
Hypertonic solutions, 67, 138
Hyphaema, 141
Hypopyon, 147
Hypotonia, 76, 143ff, 148

Incarceration, 138, 140, *see also* Iris
Incision faults, 129
Infection, 69, 80 146ff
Injections, parenteral, 38;
retrobulbar, 75f, 127, 143;
subconjunctival, 38, 75, 143;
with adrenalin, 125
Instillation, 60, 75, 143
Instruments for operations, 74, 84, 91, 97
Insufflation, oxygen, 74, 100f, 102, 104, 105f, 133, 135;
sterile air, 133, 135, 140
Intracapsular expression, 11
Intracapsular extraction, 52, 79, 90ff, 111, 113, 114, 117, 123f, 164, 166, 169, Figs. 16*a*, 16*b*;
by sliding, 93f;
by tumbling, 91ff, 96;
complications, 129f;
data on, 161f;
using sutures, 162
Intracapsular resolution, 42, 69
Intraocular pressure, 70, 75, 105, 117, 118, 139, 142
Iodine, 60, 108
Iridectomy, 51, 75, 86ff, 110, 112, 117, 119;
"antiphlogistic", 117;
peripheral, 89ff, Fig. 15*b*;
preliminary, 119;
reconnaissance, 118;
technique, 88f, 89ff, Fig. 15*a*
Iridocyclitis, 144
Iridodonesis, 68
Iridotomy, 75, 86, 89f, Fig. 15*c*
Iris, 9, Fig. 1;
adhesion to vitreous, 142;
blocking of chamber angle, 141;
incarceration, 112, 129, 140
ingrowth of, 155;
prolapse of, 104, 112, 129, 139;
replacement of, 104

Iritis, 144,
Irrigation, advantages of, 107f

Kalt forceps, 91
Keratitis striae, 102f, 133, 136
Keratome, 84, 112;
section with, 87, Fig. 14*b*
Keratophy, bullous, 136f
Ketosteroids, 34
Knapp knife, 111
Kuhnt's method, 138
Kymotraze, 95

Lactotherapy, 66
Lens, acrylic, operation, 168;
artificial, 158, 165, 167, 168, 169;
contact, *see* Contact lenses;
crystalline, 9ff, Fig. 1;
anomalies of, 162;
dislocation, 131f;
displacement of, 69, 130;
extraction with loop, 130f, Fig. 18;
rescue of, 131f
Lens fibre, 9, 10, 52, 57
Lens-prosthesis (*see* Lens, artificial)
Lens star, 11
Leucoma, 50;
central, 110
Lightning cataract, 32f, Fig. 10
Linear knife, 112
Localizer, 48
Luminal, *see* Phenobarbital

Macular degeneration, 144
Magnesium chloride, 61
Management, preoperative, 68ff
Melin, 66
Meprobamate (Andaxin), 58
Mercuric oxycyanide, 72
Mesaton, 36, 39
Methenamine, 67, 146
Microphthalmus, 18
Miosis, 27
Morphine, 125, 150
Mydriatic drugs, 36
Mydriatic effect, 37f
Myopia, 26;
cataract with, 26, 113f, 169

Nembutal, *see* Pentobarbital sodium
Neuritis of optic nerve, 148
Nicotinic acid, 61, 143
Noradrenalin, 164
Novocain, 58, 75, 77, 108
Nystagmus, 18

Ointments, objections to, 72, 128
Operating theatre, preparation of, 73ff
Operative field, toilet of, 107ff
Operative trauma, 145
Opium, 71
Osmotherapy, 66f, 143
Ophthalmologists, 2nd Congress of, 96, 162, 163, 164, 165, 166, 167, 168
Ophthalmoscope, electric, 48
Oxygen, anti-inflammatory effect, 106;
biochemical action, 106;
haemostatic effect, 103, 106
insufflation, 74, 100f, 102, 104, 105f, 133, 135;
mechanical action of, 101;
resolvent effect, 106
Oxygen therapy, 59f, 122, 143, 146, 170;
method of, 62

Pantopon, 58
Parasympatholytic agents, 36
Penetrating injuries, 29f
Penicillin, 72, 108, 147
Pentobarbital sodium, 71
Pharmacology, 169
Phenamine, 36, 39
Phenobarbital (Luminal), 71
Phonurite, 122, 139
Photoperception, 48ff
Pilocarpine, 140
Pipolphene, 59
Plasmothrombin, 140
Platyphylline, 36, 38
Posterior chamber, 9, Fig. 10
Posterior polar cataract, *see* Cataract, posterior polar
Postoperative infection, 146ff

Postoperative management, 124ff, 136ff
Potassium iodide, 61
Potentiation of drugs, 37f, 58, 70, 162, 165
Prednisolone, 43
Preparation of patient, 133;
immediate, 70ff, 74;
physical examination, 67;
preliminary, 65ff;
psychological, 65f
Presbyopia, 39
Procaine, 28
Promedole, 58, 70, 71
Propazine, 73
Protective inhibition, 66
Proteus, 147
Pseudomonas pyocyanea, 147
Psychosis, 150
Ptosis, 27
Pupil, blocking of, 141;
dilation of, 37, 75, 107, 115, 125f, 146
Pyrotherapy, 66

Quinine, 128, 143

Radiation cataract, *see* Cataract, radiation
Radiation sickness, 34
Radium, irradiation by, 140
Retina, pigmental degeneration 26
Retinal detachment, 15, 26, 51, 105, 144
Retrobulbar haemorrhage, 74
Retrobulbar haematoma, 127ff
Retrobulbar injections, 75f, 127, 143
Rheopyrene, 58
Riboflavin, 22, 60
Ridley lenses, 168
Ridley's operation, 166
Rivanol, 72
Rutin, 66

Scissors
iris, De Wecker's, 88;
section with, 87, Fig. 14*d*;
use of, 112
Scopolamine, 36, 38, 125
Secondary cataract, *see* Cataract, secondary, After-cataract
Second signalling system, 58, 65
Section, 84ff, Figs. 14*a*, 14*b*, 14*c*
Sedatives, 65
Senile cataract, *see* Cataract, senile
Siderosis, 30
Silver nitrate, 72
Sleep therapy, 66, 165, 166, 169
Sliding extraction, 93f
Spatium retrolentali, 9
Spatula, use of, 107, 108
Speculum, avoidance of use, 74, 135
Spontaneous resolution, 42
Staphylococcus aureus, 147
Sterile air, insufflation, 133, 135, 140
Strabismus, 18;
hook, 93
Sulphanil acetamide, 108, 147, 149
Sulphonamides, 67
Suprastine, 59
Surgical treatment, *see* Treatment, surgical
Suture, bridal, *see* Bridal suture
Sutures, corneo-episclero-conjunctival, 81ff, 114, 167, Fig. 13;
materials, 81;
placement of, 80f, Fig. 13;
use of, 81, 164
Suture system, 25, 169
Sympathetic ophthalmia, 148f, 163, 168
Sympathicotropic agents, 36
Synechiae, 125;
anterior, 51, 68;
dissection of, 152;
formation of, 141;
posterior, 68, 116

Tetany, 15;
cataract with, 24, 66, 109, Fig. 7
Tetracaine (Dicaine), 72, 75, 128
Thiamine, 61

Tissue hypoxia, 59
Tissue therapy, 67
Tonics, use of, 56
Tonometric examination, 70
Torpor retinae, 156
Tranquillizers, 58, 65, 70f, 133;
potentiation of, 70
Traumatic cataract, *see* Cataract traumatic
Treatment, contraindications, 41ff;
indications, 41ff;
non-surgical, 41f, 56ff, 149, 164;
surgical, 63, 163, 166, *see also* Cataract extraction;
avoidance of pressure, 74;
complications, 127ff, 136ff;
discission, 111f;
extracapsular extraction, 79, 93, 96, 97ff, 117, 123, Fig. 17;
intracapsular extraction, 52, 79, 90ff, 111, 113, 114, 117, 127f, 164, 166, 169. Figs. 16a, 16b;
operation, 74ff, 152, 163;
preparation for, 70ff;
section, 84ff, Figs. 14*a*, 14*b*, 14*c*;
techniques, 80f, 164
Trephination of sclera, 136
Trichloracetic acid, 140
Trypsin, 95, 165, *see also* Alpha-chymotrypsin
Tumbling extraction, 91f, 96

Ultra-violet rays, 36
Urotropin, *see* Methenamine
Uveitis, 25, 27, 42, 116ff, 141, 148;
anterior, 97, 143, 144;
cataract with, 27, 116ff;
seroplastic, 148;
sympathetic, 47, 148f

Vicasol, 135
Viceine, 62
Visual acuity
improvement of, 153ff, 165, 166;
limits of, 45, 48;
testing of, 154, 170
Vitamins, 54, 59, 61, 66, 137;
vitamin B, 59, 137;
vitamin C, 61, 139, 140, see also Ascorbic acid;
vitamin E, 59, 141;
vitamin K, 66, 135, 166;
vitamin P, 66;
vitamin PP, 140
Vitamin therapy, 59, 60
Vitreous (body), 9, 69, 92, 152, Fig. 1;
exclusion, 104ff;
hernia of, 133f;
ingrowth of fibrils, 155;
loss, 113, 131, 132ff, 144, 163;
prolapse, 132ff, 139, 141, 145;
protrusion, 133f;
retention, 105f
Von Graefe method, 169
Vossius' ring, 29

War, 55
Weber's loop, 93, 130
Wenzel's operation, 118

X-rays, damage by, 33;
irradiation by, 140;
perception of, 49, 162, 164

Zones of discontinuity, 11
Zonular lamella, 10
Zonule of Zinn, 10
Zonulolytic preparations, 95, 167, 170, *see also* Enzymes, Alpha-chymotrypsin

TO THE READER

Mir Publishers would be grateful for your comments on the content, translation, and design of this book. We would also be pleased to receive any other suggestions you may wish to make.

Our address is:
Mir Publishers,
Pervy Rizhsky Pereulok 2,
Moscow, USSR.

Printed in the Union of Soviet Socialist Republics